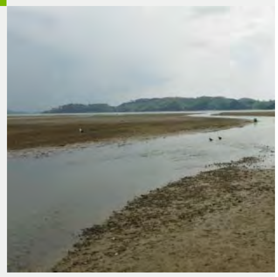

Coromandel Wharf Upgrade

Preliminary Sediment Quality Assessment

Reference: 237899
Prepared for: Cranleigh
Revision: 0
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Executive summary

Cranleigh (the Client) have engaged Aurecon to undertake a preliminary sediment quality assessment of potentially contaminated marine sediments within the littoral zone around the proposed Coromandel Wharf and Marina Development site.

The Coromandel Township is located at the mouth of Furey's Creek (also known as Whangarahi Creek) on the western coast of the Coromandel Peninsula. The creek catchment and the shoreline around the town has a long history of mining, industrial, marine and agricultural land use with potential to create and remobilise potentially contaminated material.

The proposed study area is located adjacent to the current shoreline located adjacent to Wharf Road, to the west of Coromandel Town centre. The town situated near to the northern shoreline of the Coromandel Harbour, a natural harbour on the western coastline of the Coromandel Peninsula. The study area is adjacent to an area of mixed commercial, marine, industrial and residential land use built up around the shoreline. A closed landfill site is also located within an area of current reserve. The Wharf Road Bridge over Furey's Creek marks the eastern extent of the study area, while Coromandel Wharf marks the western extent.

Dredging in and around the shoreline at Coromandel Town to facilitate further development within this area has been considered by various organisations across the last couple of decades. This has resulted in a lot of previous assessments and investigations having been undertaken. Of most note, is the previous sediment sampling exercise undertaken by PDP in 2012 near to the current wharf, which identified arsenic within sediments collected at depth above ANZECC (2000) Interim Sediment Quality Guidelines (ISQG-High) criteria.

The current phase of sediment sampling was undertaken by Aurecon in November 2013, under the supervision of Thames Coromandel District Council. Sampling was undertaken at low tide, and primarily focussed on the proposed channel extending seawards from the mouth of Furey's Creek. The results indicate the presence of arsenic (9 locations) and mercury (8 locations) above ISQG-Low criteria. These concentrations do not exceed ISQG-High criteria. The remainder of the metals tested are at concentrations below the same respective criteria. The results indicate enriched levels of trace elements, with no discernible pattern or trend observed within the current data set.

Before any practical solutions can be addressed further investigation and sampling of deep core samples to are required to properly assess and confirm the horizontal and vertical extents of potentially contaminated sediment material. These investigations should incorporate depth sampling, elutriation testing and bioavailability analysis to fully assess the impacts to marine biota.

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Tables

1 Introduction

1.1 Introduction

Cranleigh (the Client) have engaged Aurecon to undertake a preliminary sediment quality assessment of potentially contaminated marine sediments within the littoral zone around the proposed Coromandel Wharf and Marina Development site.

The purpose of the assessment is to establish a preliminary assessment of potential sediment quality to provide an initial appraisal of the risks to human health and environment associated with proposed redevelopment works of the Coromandel Wharf. This report is prepared in accordance with telephone and e-mail correspondence held between Aurecon, the Client and representatives from Thames-Coromandel District Council between 1 November and 12 November 2013.

1.2 Project background

The Coromandel Township is located at the mouth of Furey's Creek (also known as Whangarahi Creek) on the western coast of the Coromandel Peninsula. The creek catchment and the shoreline around the town has a long history of mining, industrial, marine and agricultural land use with potential to create and remobilise potentially contaminated material.

The Coromandel Coastline falls within the remit of the Waikato Regional Council and is considered to be an extremely sensitive ecological environmental receptor, especially areas of sand and mudflat, which comprises much of the study area discussed within this report.

The historical mining, industrial and urban activities can result in the input of various trace elements and organic compounds into such environments. The following are typical examples that may lead to increased concentrations within the current study area:

- Sediment run off from mined rocks and tailings releasing heavy metals such as antimony, arsenic, copper, mercury
- Enhanced deposition of trace elements as a result of deforestation and clearance of bush for agricultural purposes leading to increased weathering and erosion of soils within the catchment following Polynesian and European settlement. A study conducted by Ritchie (2000) indicated grazed hill country yields up to five times more sediment than similar terrain under native bush.
- Agricultural run-off as a result of increased use of agrichemicals such as fertilisers, pesticides and heavy metals
- Increased heavy metal content from sewerage and stormwater outflow
- Increased solvents and other organic compounds from the use of marine anti-fouling paints and lubricants
- The storage, combustion and spillage of leaded and unleaded fuels in and around the harbour shoreline can lead to release of organic compounds, hydrocarbons and trace elements within the sediment profile.

A proposal exists to undertake a significant redevelopment of the shoreline in and around the current Coromandel Wharf, Furey's Creek and intermediary shoreline. This redevelopment will increase the

capacity of the wharf to receive larger marine vessels, whilst creating a marina and developing commercial and residential activities around the current wharf.

To facilitate the development it is likely that disturbance and dredging of materials within the current tidal flat environment will be required. This material will be used partially for land reclamation, while the remainder will be disposed elsewhere.

The disturbance of these materials may lead to release of contaminated sediment within the water column that may negatively affect nearby environmental receptors and aquaculture industries if not managed.

In addition the disposal of dredged material, whether inside or outside of the Coastal Marine Area (CMA), may be necessary following dredging activities. Disposal or deposition can have adverse effects on coastal processes, water quality, sediment quality and ecology, and effectively smothers a portion of the seabed along with its associated flora and fauna. Longer term impacts can also occur as sediment becomes re-suspended or as contaminants continue to leach into the water body.

Aurecon are engaged to undertake a preliminary screening of sediments around the proposed area of dredging to assess the present of contamination within the upper profile of marine sediments within the study area. This scope is considered to be a first pass to provide an indicative assessment of conditions, and will provide the platform for more detailed studies to be undertaken as the project progresses.

1.3 Objectives and approach

The objectives of this exercise were to provide a preliminary assessment of the condition of sediments within likely areas of dredging. In order to provide an indicative assessment of likely conditions, it was proposed to undertake a review of relevant desktop information made available by the Client's project team as well as other publically available information. This was supported by a site inspection of the shoreline within the proposed study area, as well as a preliminary sampling exercise of surface marine sediments within the proposed areas of dredging.

Sampling of marine sediments were undertaken following general procedures for sample collection, preservation and testing set out within *New Zealand Guidelines for Sea Disposal of Waste (Part 2; Section 1 – Supplementary technical guidelines on waste sampling and characterisation)* (June 1999) and *MfE Contaminated Land Management Guidelines No. 5 – Site Investigation and Analysis of Soils* (Revised 2011).

Interim Sediment Quality Guidelines (ISQG) developed in 2000 by the Australian and New Zealand Environment and Conservation Council (ANZECC) have been developed to provide information on whether selected trace elements and organic compounds are elevated, and as such present risk to identified environmental receptors. These replace earlier guideline values listed within *New Zealand Guidelines for Sea Disposal of Waste* and previous ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters*.

These guideline values are utilised by Waikato Regional Council to assess the potential for risk to receptors as a result of marine sediment disturbance and dredging activities. This is managed through Chapter 7 of the Waikato Regional Coastal Plan which relates to foreshore and seabed dredging and disturbances, which forms the basis for discussion associated with the proposed activities.

1.4 Limitations of this report

Aurecon has prepared this report in accordance with the brief as provided. The contents of the report are for the sole use of the Client and no responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other

purposes without Aurecon's prior review and agreement. Marine sediment formations are often variable, resulting in heterogeneous distribution of contaminants across a given site or study area.

Contaminant concentrations may be estimated at chosen sample locations, however, conditions between sample sites can only be inferred on the basis of geological and hydrological conditions and the nature and the extent of identified contamination. Boundaries between zones of variable contamination are often indistinct, and therefore interpretation is based on available information and the application of professional judgement.

Only a finite amount of information has been collected to meet the specific technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The report does not provide a complete characterisation of likely dredge areas, and considered to be a pilot study in nature. The nature and continuity of the ground between test locations has been inferred using experience and judgment and it must be appreciated that actual conditions could vary from the assumed model.

This report does not provide a complete assessment of the environmental status or implications from proposed activities within the study area, and it is limited to the scope defined herein. Should further information become available regarding the conditions at the site, including previously unknown likely sources of contamination, Aurecon reserves the right to review the report in the context of the additional information.

This report has been prepared for the Client for its own use and is based on information provided by them. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that the Client may suffer as a result of using or relying on any such information or recommendations contained in this report, except to the extent Aurecon expressly indicates in this report that it has verified the information to its satisfaction. This report is not to be reproduced either wholly or in part without our prior written permission.

2 Site setting

2.1 Site location

The proposed study area is located adjacent to the current shoreline located adjacent to Wharf Road, to the west of Coromandel Town. The town is located near to the northern shoreline of the Coromandel Harbour, a natural harbour located towards the northern end of the western coastline of the Coromandel Peninsula. The town is centred on Furey's Creek which comprises the outlet for the northern most of three main catchments that drain into the harbour. A plan showing the site location is presented on Figure 1, Appendix A. The site is noted to be a regionally significant coastal environment, while the Harbour is classified as an Area of Significant Conservation Value.

2.2 Site description and surrounding land use

An inspection of the shoreline was undertaken by Aurecon's Senior Geoenvironmental Engineer on 19 November 2013. For the purpose of this assessment, the site study area extends along the northern bank of the Furey's Creek Channel from the Wharf Road Bridge in the east, to the Coromandel Wharf in the west. The study area extends approximately 300 m out across the tidal mudflat between Coromandel Wharf and the Creek channel. The study area also comprises the area of land between the current shoreline and Wharf Road.

The Wharf Road Bridge is located at the eastern end of the study area, and is the closest point from the Coromandel Town centre. From the bridge, the area directly to the south of the road comprises a number of mixed uses; a small waste water pump station, a boatyard and some public amenities (public toilets, recreational facilities). To the north of Wharf Road, is a 'G.A.S' petrol refuelling and service station.

This area of mixed use extends approximately 275 m along the northern part of the creek channel to a large public car park area and boat ramp, at which point the channel opens out into the Coromandel Harbour. The channel at this point is lined with pockets of mangrove, and at low tide exposes the muddy (silt and clay) channel bottom. The mangrove area extends for another 200 m from the boat ramp.

To the north of the car park is an area of grass reserve, which marks the location of a closed landfill. The construction and contents of the landfill are not well known. The shoreline perimeter of the landfill is protected by a rip-rap boulder wall. Beyond the landfill, Wharf Road re-joins the shoreline and continues around the headland to Coromandel Wharf. Between the headland and the wharf, a large sand and silt tidal flat is exposed. The flat contains a lot of sand, silt and shell beds. A number of residential properties are located to the north of the road in this area.

The Coromandel Wharf itself is a small commercial wharf, constructed on rip-rap boulders with a seal road extending out approximately 340 m to the west from the headland. The wharf is approximately 340 m long and used by both private and commercial marine operating vessels. A refuelling point is located at the end of the wharf. Beyond the wharf, the road loops back around to the north. A large aquaculture mussel processing industry is located on the shoreline at this point, before retreating into an area of predominantly residential land use.

2.3 Geological and hydrogeological setting

The study area comprises Holocene alluvial and estuarine sediments largely derived from the creek. A review of the 1:250,000 scale map of the Auckland Region (IGNS Sheet 4) indicates much of Coromandel Town is constructed on Quaternary alluvial deposits. These deposits are derived from two significant geological formations, the Kuaotunu Subgroup and the Te Mata Subgroup.

The Kuaotunu Subgroup forms the majority of the Coromandel Peninsula landscape and comprises a mixture of volcaniclastic material; andesite and dacite intrusives, flows, volcaniclastites and volcanic epiclastites. This material has been subject to extensive hydrothermal alteration and is the source material of much of the Coromandel Peninsula's mineralogical wealth.

The Te Mata Subgroup comprises late Jurassic-aged basement marine sedimentary rocks, uplifted and exposed at the surface to the east of Coromandel Town. The subgroup comprises interbedded sandstone, siltstone and mudstone with conglomerate and sedimentary breccia. Faulting is recognised as still being active within the Hauraki Rift, a tectonic zone to the west of the peninsula.

Both the older sedimentary deposits and the later volcanic sequence contain epithermal vein systems from which over 3,200 kg of gold bullion with high silver content has been produced to date (Skinner, 1993).

2.4 Proposed development activities

The proposed develop will see an upgrade of the wharf facilities at the entrance to Furey's Creek to facilitate berthing of larger vessels. To facilitate the upgrade, the existing channel will be enlarged and the new wharf will be located within an area of new land reclamation. It is expected that site won sediments will be used for land reclamation purposes.

This will be won through dredging activities within the current creek, and between the current channel and pier. A marina is proposed to be constructed to the west of the new wharf. Based on correspondence with the project design team, it is expected that the upper 1.7 m of marine sediment will require dredging to facilitate the proposed development. A plan showing the indicative development layout is presented on Figure 1, Appendix A.

The potential for a marina development in the Coromandel Town area has long been on the horizon, with feasibility studies having been undertaken dating back to the 1990s.

2.5 Historical setting

The Coromandel Peninsula has a long history of gold mining and kauri forestry dating back to early European settlement. The first gold was discovered locally in 1852 (Skinner, 1993) and consequentially the earliest known gold mining activities took place at Driving Creek[1], located to the north of Coromandel Town and which drains to the Coromandel Harbour via Furey's Creek. This commenced in the early 1860s, and evidence of late 19th century and early 20th century activities still remain around the peninsula today.

Gold was mostly found within low-grade quartz veins and were extracted using the cyanide extraction process method, which yields significant volumes of waste rock and mine tailings. Based on known historical mining techniques in the Coromandel Area, trace element enrichment of waterways occurred through two main processes: direct deposition of mine tailings into waterways; and through acid mine drainage where minerals are released through the oxidation of sulphides which are then flushed out via groundwater or surface water overland flow paths following heavy rainfall events.

[1] http://www.thepeninsula.co.nz/coromandel/history.htm (accessed 2 December 2013)

Beyond its commercial and industrial beginnings, the peninsula has long been a popular tourist destination with significant residential and holiday residential development having occurred in the last 100 years.

2.6 Previous assessments and studies

2.6.1 Introduction

The Coromandel Harbour area has been subject to many previous studies and assessments to confirm or investigate the local environmental setting. Assessments reports relevant to the proposed development and its likely effects are summarised in the following sub-sections. A plan showing historical sample locations around the study area is presented on Figure 1, Appendix A.

2.6.2 A Revised Assessment of Biological and selected Chemical Effects relating to proposed channel improvements at Furey's Creek, Coromandel Harbour (Brian T. Coffey, September 1992)

A study undertaken by Brian T. Coffey and Associates in September 1992 provides a discussion of biological and chemical impacts as a result of dredging the Furey's Creek channel. The proposal was to dredge between 1.3 and 2.06 m of the existing channel to improve haul out facilities for boat operators.

The report notes the presence of the closed landfill between the shoreline and Wharf Road, whilst also acknowledging the potential impact as a result of historical mining within the headwaters of the Whangarihi Stream / Fureys Creek catchment. The report notes that the Coromandel Harbour and Furey's Creek area has a significant siltation problem and is noted to have high suspended sediment contents.

The report notes the sediments around the channel to comprised layers of gravel with intermittent mud and sand to a depth of 1.50 m bgl. The sediments were noted to have a high oxygen depleting potential (800 – 1,430 mg/kg) if unduly mixed with receiving water.

As part of the assessment, composite samples from 4 locations (A to D respectively) between a depth of 0.0 m bgl and 1.5 m bgl. Samples were recovered at low tide with a split-spoon corer. The report notes the concentration of arsenic, copper, lead, zinc and mercury to be below threshold guideline criteria reported by the United States Environmental Protection Agency (USEPA). When assessed against ANZECC (2000) sediment quality guidelines, all concentrations were found to be below ISQG-Low screening criteria, with the exception of mercury concentration within Core A, which recorded a concentration of 0.18 mg/kg; slightly elevated above 0.15 mg/kg. Biological Oxygen Demand (BOD) was found to vary between 170 mg/kg (Core A) and 1430 mg/kg (Core B)

A copy of the Coffey report is presented in Appendix B.

2.6.3 Coromandel Wharf Condition Survey (Maunsell AECOM, August 2005)

A brief condition report undertaken by AECOM in August 2005 notes the presence of a buried fuel storage tank and a bunded diesel fuel pump within the 'central section of the main wharf area'. This tank and fuel dispenser infrastructure is still present and in operation. The wharf was noted to be in poor condition. The pump is noted in a later conditions report (Peninsula Civil, March 2008) to be operated by Caltex and includes an oil water separator.

2.6.4 Phase 1 Divestment Assessment, Coromandel Boat Shop (Caltex, 2010)

An inspection was undertaken of the diesel storage tank located at the end of the Coromandel Wharf in 2010. The following information is noted:

- The current tank was installed in 1999, replacing a historical tank installed in 1992. The tank is a double skinned tank with a steel inner, and fibreglass outline lining.
- The tank has a capacity of 30,000 L and is used to store diesel. An integrity test was last undertaken in February 2010. Some pipework was replaced in 2009.
- The tank does not have any secondary containment systems.
- No fuel loss or free product spillage was recorded at date of report publication. No product was noted in two monitoring wells.
- Anecdotally, it was understood harbour water is monitored on a weekly basis by local aquaculture industries.

A copy of the inspection report is presented in Appendix C.

2.6.5 Sediment Quality Assessment at Coromandel Wharf (PDP, March 2012)

Pattle Delamore Partners Ltd (PDP) undertook a limited sediment quality assessment at the Coromandel Wharf for Thames Coromandel District Council (TCDC). The purpose of the assessment was to ascertain the concentration of metals around the wharf in consideration of proposals to dredge materials for development of upgraded wharf facilities.

The sampling comprised collection of five discrete surface sediment samples (0.0 – 0.10 m depth) and five sediment cores were collected along the southern side of Coromandel Wharf. All samples were submitted to Hill Laboratories for analysis to determine total recoverable (US-EPA method 200.2) arsenic, cadmium, chromium, copper, lead, mercury, nickel; and zinc. Five samples were also tested for antimony and organotin compounds (dibutyltin, monobutyltin, tributyltin and triphenyltin), typically associated with marine paints and solvents. The samples were collected in December 2011; the results of which were reported in March 2012.

The discrete surface samples tested for concentrations of organotin and antimony taken near Coromandel Wharf found detectable levels of dibutyltin and tributyltin in one sample (COR-005). The dibutyltin and tributyltin concentrations were found to slightly exceed ANZECC (2000) Interim Sediment Quality Guideline ISQG-Low guideline values. However, it should be noted that these sample concentrations were not normalised for 1% Total Organic Carbon (TOC) in accordance with ANZECC (2000) protocol and as such cannot be used to assess against ISGQ criteria. The effects of the natural sediment and water chemistry have effect on partitioning of organic compounds, and as such PDP have not considered these factors in their assessment.

With the exception of one location (CMW03, 0.0 – 0.20 m) the concentration of mercury in all samples exceeded ANZECC (2000) ISQG-Low guideline values with concentrations ranging from 0.196 mg/kg to 0.81 mg/kg. Furthermore three samples CMW01, CMW02 and CMW04 taken at 0.30 - 0.34 m, 0.4 m and 0.3 m depth below the sea bed respectively, exceeded the ANZECC (2000) ISQG-high guideline value for mercury with concentrations ranging from 1.52 mg/kg to 3.1 mg/kg.

The concentration of arsenic exceeded the ANZECC (2000) ISQG-low guideline values in three of the six discrete surface samples (COR003, COR004 and COR006) with values between 23 mg/kg

and 27 mg/kg, with the other three samples close to the ISQG-low guideline value (20 mg/kg). Other trace elements (cadmium, chromium, copper, nickel and zinc) analysed at Coromandel Wharf showed concentrations of' these elements were lower than the relevant ANZECC (2000) ISQG-low guideline value.

As the concentrations of arsenic and mercury within the sediment samples were identified between the ISQG-low and ISQG-high guideline values, and three further samples were found to contain concentrations above the ISQG-high guideline values the sediments were considered to be hazardous in accordance with the Waikato Regional Council Coastal Management Plan.

A copy of the PDP report is presented in Appendix D.

3 Preliminary sampling

3.1 Introduction

As part of Aurecon's site inspection, a preliminary sediment sampling exercise was undertaken by Aurecon with assistance from Francois Pienaar of Thames Coromandel District Council. The sampling was undertaken on Tuesday 19 November, selected due to appropriate low tide times allowing access to the furthest extent of the tidal flats.

3.2 Sampling methodology and laboratory analytical schedule

A total of 10 manual grab samples were collected by gloved hand and placed into clean plastic containers provided by the laboratory. Sample locations were primarily located at regular intervals along the northern bank of the existing channel, while additional samples were collected at accessible areas of the tidal mudflat within the area of the proposed marina. One further sample was collected at the base of the existing boat ramp at Furey's Creek.

The sample material was logged in accordance with New Zealand Geotechnical Society (NZGS) F*ield Classification of Soil and Rock for Engineering Purposes* (2005). The position of each sample location was recorded using a hand-held GPS unit, programmed to New Zealand Transverse Mercator co-ordinate system. The samples were placed on ice and couriered under chain of custody to the laboratory in a sealed chilly bin. The job number, sample name, time and date were recorded on each sample. Each sample (a total of 10) collected was submitted for the following analytes:

- pH
- Arsenic
- Antimony
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Vanadium
- Zinc
- Total Cyanide

Laboratory analytes were selected to assess the influence from mining related activities. Given the limited scope of sampling and testing, field quality assurance / quality control samples or procedures were not undertaken, however the laboratory is IANZ-accredited and as such internal QA/QC is required to be undertaken to ensure reliability of reported test results.

3.3 Results of investigation

To establish the degree of risk to marine sediment-dwelling organisms and other ecological flora and fauna, the results of the laboratory analysis can be compared with Australian and New Zealand Environmental Conservation Council (ANZECC, 2000) interim guideline values for sediment quality (ISQGs). These values are designed to determine the impact to aquatic ecosystems and should not be utilised as a measure of risk to human health. A summary of the collected samples is presented in Table 1.

Table 1 Summary of sediment sampling locations

Location	Location detail	Easting	Northing	Odour	Material
AU13-001	North bank of channel, 3 m inland from 3rd buoy	2732444	6489915	No	CLAY with minor fine sand
AU13-002	North bank of channel, 4th buoy	2732491	6489915	No	Shelly fine to coarse SAND, with silt and gravel
AU13-003	North bank of channel, halfway between 4th and 5th buoy	2732552	6489935	No	Shelly fine to coarse SAND, with silt and gravel
AU13-004	Proposed marina area between channel and wharf	2732490	6489979	No	Clayey fine to coarse SAND, with trace gravel
AU13-005	North bank of channel 5th buoy	2732591	6489947	No	Clayey fine to coarse SAND, with trace gravel
AU13-006	North bank of channel, 6th buoy	2732625	6489953	No	Sandy CLAY
AU13-007	North bank of channel, 40 m of 7th buoy	2732707	6489970	No	Sandy CLAY
AU13-008	South-west edge of mangrove area	2732759	6490000	No	CLAY, some organic material (mangrove, leaf litter)
AU13-009	Halfway between Jacks Point and wharf	2732511	6490093	No	Silty CLAY trace fine sand
AU13-010	Boatramp - eastern side	2732936	6490123	No	Silty CLAY, trace sand, some discolouration

3.3.1 Assessment criteria

For each trace element and organic compound, ANZECC has derived a low interim sediment quality guideline value (ISQG-Low) and a high interim sediment quality guideline value (ISQG-High). The ISQGs relate to the toxic effects of trace elements and organic compounds on sediment-dwelling organisms.

The ISQG-Low value is considered by ANZECC to indicate the level below which adverse effects are very unlikely (low likelihood of toxic effects). As such, it is not a level that is cause for concern but typically regarded as the trigger point indicating the need for further investigation.

The ISQG-High value is a level at which adverse effects are expected in 50% of nearby organisms exposed to affected sediments. Concentrations above the ISQG-High value are therefore interpreted as being ‘reasonably likely’ to cause significant adverse effects on aquatic organisms (high likelihood of toxic effects).

Between the ISQG-Low and ISQG-High values the effects of trace elements and organic compounds are unknown and require more specific assessment to appropriately characterise the risks. But, for the purpose of this assessment they are considered to pose a moderate level of risk to exposed organisms (moderate likelihood of toxic effects).

3.3.2 Results of laboratory testing

It should be noted that these results have not been compared against sediment data for an area of similar geological and hydrogeological setting, but not considered to have been affected by anthropological processes. It should also be noted that given the limited nature of the sampling regime it is not appropriate to apply statistical analysis to the data set. The results of laboratory analysis are presented in Table 2. A copy of the Hills Laboratory Certificate of Analyses is presented in Appendix E of this report.

The results indicate the presence of arsenic (9 locations) and mercury (8 locations) above ISQG-Low criteria. These concentrations do not exceed ISQG-High criteria. The remainder of the metals tested are at concentrations below the same respective criteria. The results indicate enriched levels of trace elements, with no discernible pattern or trend observed within the current data set.

A sediment quality guideline value is not available for cyanide, however to provide some context, the recorded values are all below CCME[2] human health screening criteria for residential land use (0.9 mg/kg). The maximum acceptable value for cyanide within drinking water is 0.2 mg/L. The ANZECC (2000) water quality guideline for protection of ecosystems is set at 4 µg/L. Further analysis of sediment pore water samples and assessment against ANZECC water quality criteria has not been undertaken as part of the current scope.

[2] Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Canadian Council of Ministers of the Environment, 1997

Table 2 Summary of laboratory test results

Analyte	ISQG-Low (mg/kg)	ISQG-High (mg/kg)	AU13-001	AU13-002	AU13-003	AU13-004	AU13-005	AU13-006	AU13-007	AU13-008	AU13-009	AU13-010
Location	-	-	Channel	Channel	Channel	Marina	Channel	Channel	Channel	Channel	Marina	Boatramp
pH	-	-	8	8.3	8.3	8.2	8.1	8.1	8	7.7	8.3	7.9
Total Cyanide	-	-	< 0.10	0.14	< 0.10	< 0.10	< 0.10	< 0.10	0.5	< 0.10	0.64	< 0.10
Arsenic	20	70	**26**	**25**	**24**	**25**	**28**	**28**	**20**	18	**21**	**20**
Antimony	2	25	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Cadmium	1.5	10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.12	< 0.10
Chromium	80	370	18	14	12	15	19	16	24	21	14	31
Copper	65	270	21	20	17	19	21	21	19	14	12	23
Lead	50	220	34	24	25	56	29	**59**	26	20	22	24
Mercury	0.15	1	**0.16**	< 0.10	< 0.10	**0.22**	**0.2**	**0.18**	**0.18**	**0.24**	**0.18**	**0.23**
Nickel	21	52	7	6	7	6	7	6	7	6	5	9
Selenium[2]	24.2[3]	N/A	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Vanadium[2]	169.8[4]	N/A	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100
Zinc	200	410	90	80	74	93	89	87	78	66	81	91

1. Values in bold are at or exceed ISQG-Low screening criteria
2. In the event guideline criteria are not available for certain analytes, ANZECC (2000) indicates utilising a natural referenced background level multiplied by a factor of 2.
3. Background of 12.1 mg/kg selected for Selenium in Waikato, based on McNally (2011)
4. Background of 84.9 mg/kg selected for Vanadium in Waikato, based on Environmental Waikato Technical Note: *Trace Elements in the Sediment of Waikato West Coast Estuaries* prepared by PDP in March 2009.

4 Conclusions and recommendations

4.1 Conclusions

The local catchment has been assessed to have a history of potentially contaminating activities, primarily from gold mining activities but also more recently from additional activities such as agriculture, marine maintenance, landfilling and the bulk handling and storage of fuels. In addition, increased erosion from deforested natural slopes can lead to a more natural enrichment of trace elements.

The aforementioned activities have potential to impact sediment deposited from Furey's Creek around the study area shoreline. Previous sediment sampling has identified increased concentrations in metals (particularly arsenic and mercury) in close proximity to the Coromandel Wharf. In particular, concentrations of arsenic were found to be above ISQG-High criteria within deeper sediment samples, which were not tested as part of the current scope.

The results of the sampling and testing programme undertaken as part of the current scope indicate the presence of increased heavy metal concentrations. Given the limited nature of the data set it is difficult to provide a clear assessment of likely source or any trending patterns; however the presence of low cyanide concentrations may point towards a degree of likely impact as a result of historical mine workings.

A trending pattern is the increased concentrations of arsenic and mercury throughout, which were found to slightly exceed ISQG-Low screening values during the current phase of lab testing. These values are generally conversant with surface sediment samples collected by PDP in 2012; however they are less than deeper samples tested as part of the same PDP investigation. This may indicate increased concentrations of trace elements at depth across the proposed dredge site.

It should also be noted that the samples were primarily taken in an area near to the existing channel which is a far more dynamic environment. As such these sediments have been 'diluted' by incoming 'clean' sediment coming from the creek. The channel area is also likely to be significantly impacted by other processes such as increased scour and deposition. This may be compared against the results of PDP's analysis where samples were collected from an area of reduced movement and re-working.

The results were found to be generally similar to test results prepared by URS and published by the Environment Waikato Regional Council in May 2007, where testing of foreshore areas around the Lower Eastern Coast of the Firth of Thames identified enriched arsenic, cadmium, copper, mercury, lead and zinc.

The test results reported by URS were not considered to be extremely high but given some ISQG-Low criteria were exceeded, some adverse effects on marine biota may be expected. It was considered by URS that more sampling and testing was required to determine trends or patterns over time. It should be noted that the samples collected by URS were also recovered from the near surface also. The presence of trace metals may be the result of increased erosion and sedimentation in an area known to have high siltation rates.

4.2 Recommendations

The sampling undertaken as part of the current scope of works was limited to within the upper 100 mm of the sediment profile. No further testing was undertaken to establish the condition of deeper sediments which may contain elevated contaminants concentrations as a result of historical activities.

In addition, the bioavailability of trace elements has not been assessed as part of the current scope. Therefore the laboratory testing results received to date measure the heavy metals and elements identified as a whole rather than distinguishing chemical forms, some of which are more problematic than others. In consideration of this, the results of the testing may overestimate the impact of identified contaminants on exposed organisms.

A limited suite of laboratory testing was undertaken to investigate potential for contamination to exist as a result of mining processes. However, as a number of other potential sources were identified to exist around the site, the analytical schedule should be widened during further phases of investigation to assess these activities also.

Before any practical solutions can be addressed further investigation and sampling of deep core samples to are required to properly assess and confirm the horizontal and vertical extents of potentially contaminated sediment material. These investigations should incorporate depth sampling, elutriation testing and bioavailability analysis to fully assess the impacts to marine biota.

In accordance with the New Zealand Guidelines for the Sea Disposal of Waste, the results received to date (between ISQG-Low and ISQG-High criteria) indicate a Level 3 investigation will be required, involving elutriate and acute toxicity testing.

5 References

Caltex (2010) Phase 1 Divestment Assessment, Coromandel Boat Shop

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Canadian Council of Ministers of the Environment, 1997

Coffey,. B. T. (1992) *A Revised Assessment of Biological and selected Chemical Effects relating to proposed channel improvements at Furey's Creek, Coromandel Harbour*

Environment Waikato Regional Council (Environment Waikato Technical Report 2007/2008) *Trace Elements in Sediments of the Lower Eastern Coast of the Firth of Thames*. Report prepared by URS, May 2007.

Environment Waikato Regional Council (Environment Waikato Technical Report 2007/2008) *Trace Elements in Sediments of Waikato West Coast Estuaries*. Report prepared by UDP, March 2009.

Guidelines for Canadian Drinking Water Quality (http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/index-eng.php, accessed 9 December 2013)

Maunsell AECOM (2005) Coromandel Wharf Condition Survey

McNally, S. R., (2011). *The Status of Iodine and Selenium in Waikato Soils*. MSc Thesis (unpublished). University of Waikato.

PDP (2012) *Sediment Quality Assessment at Coromandel Wharf.* March 2012. Ref A02435106

Peninsula Civil (2008) Coromandel Wharf Condition Survey

Appendix A
Report figures

Appendix A
Report figures

Ref No	Description
1	Basin for charter boats
2	Ferry berth
3	Ferry terminal, ecological, cultural, heritage doc discovery etc
4	Main public boat ramp
5	Dry stack haul out
6	Boat dry stack storage, retail chandlery
7	Limit of all –tides access
8	General moorings
9	Parking for boat trailer / channel moored boats
10	Overspill parking as (9)
11	Corridor accessway
12	Public spaces – 'Gateway' to Coromandel township
13	Rock revetment
14	Apartment / character terrace housing zone
15	Dredged access channel
16	Parking area for marina users and or possible future waterside apartment developments
17	Possible future marina
18	Rock rubble mound breakwater
19	Landscape set back from water's edge
20	Old boat ramp / haul-out
21	Boatyard ramp
22	Future marine engineering precint

LEGEND

- AURECON SAMPLE LOCATIONS (19/11/13)
- PDP GRAB SAMPLING LOCATIONS (NOV 2011)
- PDP CORE SAMPLING LOCATIONS (DEC 2011)
- BRIAN COFFEY CORE SAMPLES (1992)

NOTE

SAMPLE LOCATIONS INDICATIVE ONLY.

20 0 40 80m
SCALE 1:2000

aurecon
www.aurecongroup.com

CLIENT
CRANLEIGH
THAMES COROMANDEL DISTRICT COUNCIL

REV	DATE	REVISION DETAILS	APPROVED
A		FOR ISSUE - NOT FOR CONSTRUCTION	

SCALE	SIZE
1:2000	A1

DRAWN: I.HOLMES
DESIGNED: R.GRIFFITHS
CHECKED: N.PROPOSCH

PRELIMINARY
NOT FOR CONSTRUCTION

APPROVED: R.APPERLEY DATE

PROJECT: COROMANDEL HARBOUR FACILITIES

TITLE: PROPOSED DEVELOPMENT LAYOUT

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	237899	0000	DRG	CC	002	A

Appendix B

Brian Coffey Report (1992)

Appendix B
Brian Coffey Report (1992)

Brian T. Coffey and Associa

Environmental Consultants

for
Water Resource Managers

A Revised Assessment of Biological and selected Chemical Effects relating to proposed channel improvements: Furey's Creek, Coromandel Harbour.

Prepared for :

The General Manager
Thames Coromandel District Council
Private Bag, Thames, New Zealand.

Prepared by :

Brian Coffey, Ph.D.

Inquiries and References, please quote:
Brian T. Coffey and Associates Limited:
AEE / FC: T.C.D.C. 02 Coromandel, Sept. 1992.

Hillcrest, Hamilton, New Zealand. Telephone/Facsimile: 64 [07] 856 1233. Mobile: (025) 937 865.

Executive Summary

The present access channel to haul out facilities for boats at Furey's Creek is usable only at high tide. It is proposed to improve boat access to these facilities by dredging a 150 m long, 0.6 - 1.3 m deep, 6 m wide channel through inter tidal flats which will by-pass an existing dog leg and flow restriction (small section of rapids) in the exiting channel of the lower Whangarahi Stream. These works are expected to improve flushing rates and to encourage channel scouring in the lower Whangarahi stream (see Figure 1).

It is proposed to in-fill a section of the existing rapids with dredged material. Surplus dredging were to be used to line the right bank of the proposed channel and the left bank of the existing channel upstream of the proposed realignment.

This report replaces our assessment of January 1992[1] as the Waikato Regional Council has requested further information on the heavy metal content and Biological Oxygen Demand (BOD) of sediments to be dredged and disposed of during the proposed channel realignment. The basis of their information requirement is that material to be dredged and disposed of may have been contaminated by:

- mining activities in the head-waters of the Whangarahi Stream and / or
- an old rubbish dump which was located to the north of the proposed channel.

Dredging impacts in this instance will include physical removal and damage to a shell fish community (dominated by cockles and pipi) which occupy the route of the proposed channel realignment. The route of the proposed channel does not pass through more highly-valued sea grass and mangrove communities which occur in the vicinity of proposed works.

Sediments to be dredged along the route of the proposed channel comprise intermittent layers of gravel interspersed with mud and sand to a depth of 1.5 m, together with occasional deposits of soft surficial mud in surface depressions. These sediments have a high oxygen depleting potential (800 - 1,430 mg/kg) if they are unduly mixed with receiving waters.

Disposal of dredged sediments in the retired channel will result in the burial of existing communities which are dominated by worms and the potential for local water quality deterioration.

Concentrations of Arsenic, Copper, Lead, Zinc and Mercury in materials to be dredged are below threshold concentrations reported by the United States Environmental Protection Agency, but in the absence of nationally-sanctioned levels for "safe" concentrations of heavy metals in marine sediments, may be of local concern.

It is recommended that dredged material is disposed of in that section of the existing channel which is to be retired, rather than raising the level of channel embankments. This should ensure that the long term impact of proposed works is restricted to a relatively rapid spatial juxtaposition of habitat type and community structure between the two sites.

Transfer of dredged material to the retired channel with minimal physical disturbance (e.g. clam shell technology) and matching final contours for dredged material should reduce potential impacts of BOD and the potential flux of heavy metals from relocated sediments.

1 *An Assessment of Biological Effects relating to proposed channel improvements: Furey's Creek, Coromandel Harbour.* (Brian T. Coffey and Associates Limited: AEE / FC: TCDC 01 Coromandel, Jan. 1992).

2.0 Introduction

This report updates and replaces

An Assessment of Biological Effects relating to proposed channel improvements: Furey's Creek, Coromandel Harbour. (Brian T. Coffey and Associates Limited: AEE / FC: TCDC 01 Coromandel, Jan. 1992).

It considers the implications of a proposed channel re-alignment on resident biological communities in the lower Whangarahi Stream (Furey's Creek), Coromandel Harbour (see Figure 1) and reports on heavy metal concentrations and Biological Oxygen Demand in composite core samples from the area to be dredged.

A Coastal Permit (under the Resource Management Act, 1991) is required to dredge and dispose of material in this coastal marine area. The Coromandel Harbour Management Plan considers the maintenance of water quality within the harbour to be of vital importance (Thames Coromandel District Council, 23 December, 1988. - Chapter III, 2.1.1 and 2.1.2).

Furey's Creek provides a protected mooring / jetty site for the Coromandel fishing fleet and a limited haul out area for boat maintenance on Council's Recreational Reserve. A private engineering company is established within a Marine Activities Zone and provides commercial and industrial service to water users.

Furey's Creek and the mouth of the Whangarahi Stream are only workable at high tide. There is an obstruction to water flow (a small section of rapids) in the channel between the harbour and the mooring / jetty site which is both a navigation hazard and the suspected cause of siltation problems in the upstream section of channel.(see Figure 2).

Drawings provided with this brief (Keeves, 1991[2]) propose a re-alignment of the lower Whangarahi Stream channel to by pass this obstruction to water flow.

3.0 Location and description of the proposed channel re-alignment

Part of Coromandel Harbour showing the locality of the Whangarahi Stream and Furey's Creek is sketched in Figure 1. Figure 2 illustrates the existing condition in the lower section of the stream. Figure 3 summarises proposed work for channel improvements (also see Cover Plate and Plate 2).

The proposal is to dredge a 6 m wide channel through inter tidal flats to a relative level of 0.7 m which will by-pass an existing dog-leg and small section of rapids in the stream and thus improve flushing from the lower Whangarahi Stream.

Relative levels through the proposed section of the cut currently range from 1.30 to 2.06 m (Keeves, 1991), hence a depth of the proposed excavation ranges from 0.6 to 1.3 metres.

It was proposed (footnote 2) that a 10 m section of the existing rapids would be in-filled with dredged material. The remainder of spoil would be disposed of along the left bank of the existing (upstream) channel, and along the right bank of the proposed channel, as diagramed in Figure 3.

2 TCDC Proposed maintenance and channel improvements to the Whangarahi Stream, D.R. Keeves, September 1991

Figure 1. Sketch Map of part Coromandel Harbour showing locality of Furey's Creek and the Whangarahi Stream

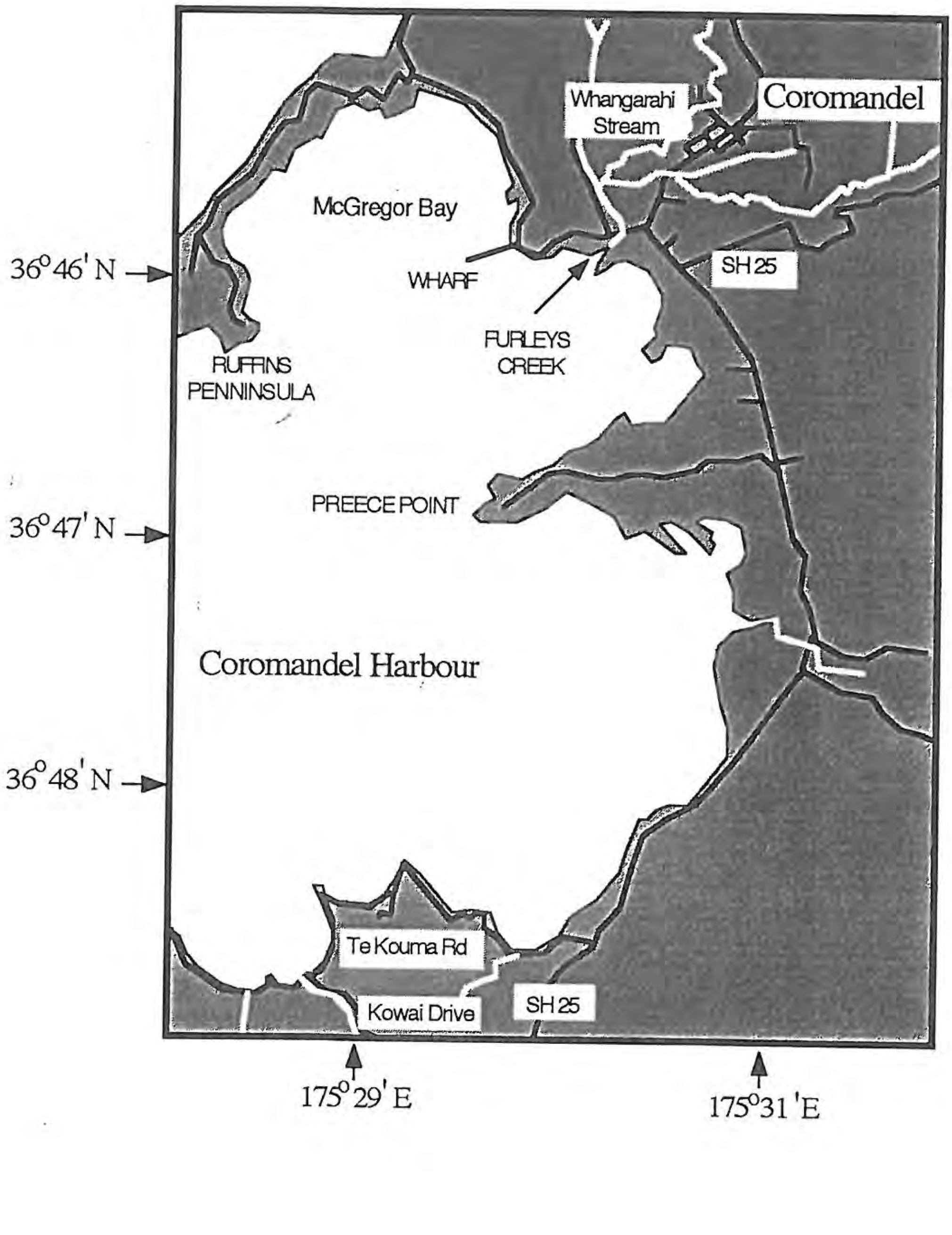


Figure 2. Sketch map of the lower Whangarahi Stream showing distribution of existing communities and vantage points (u, v, w, x, y, z) for colour plates

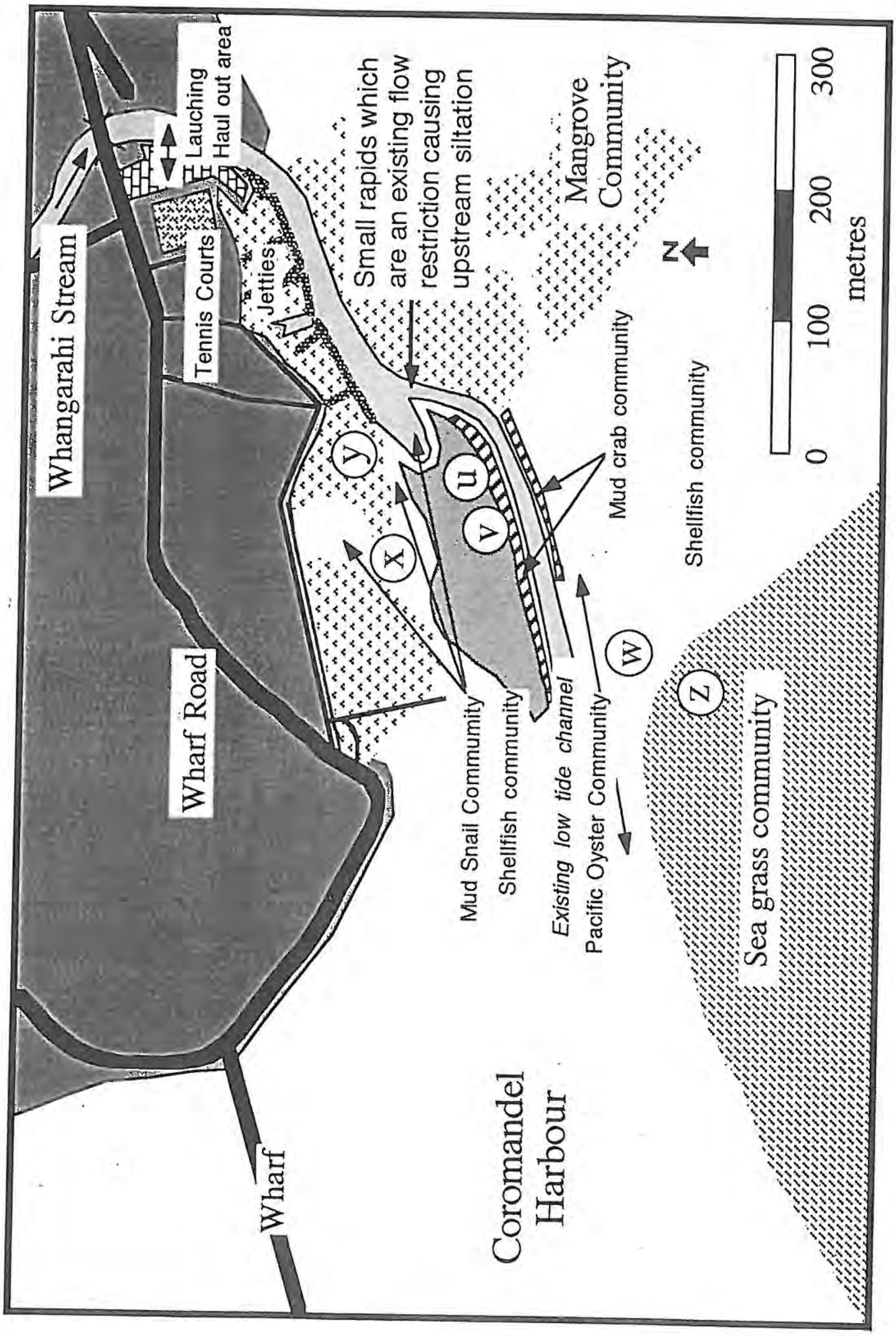
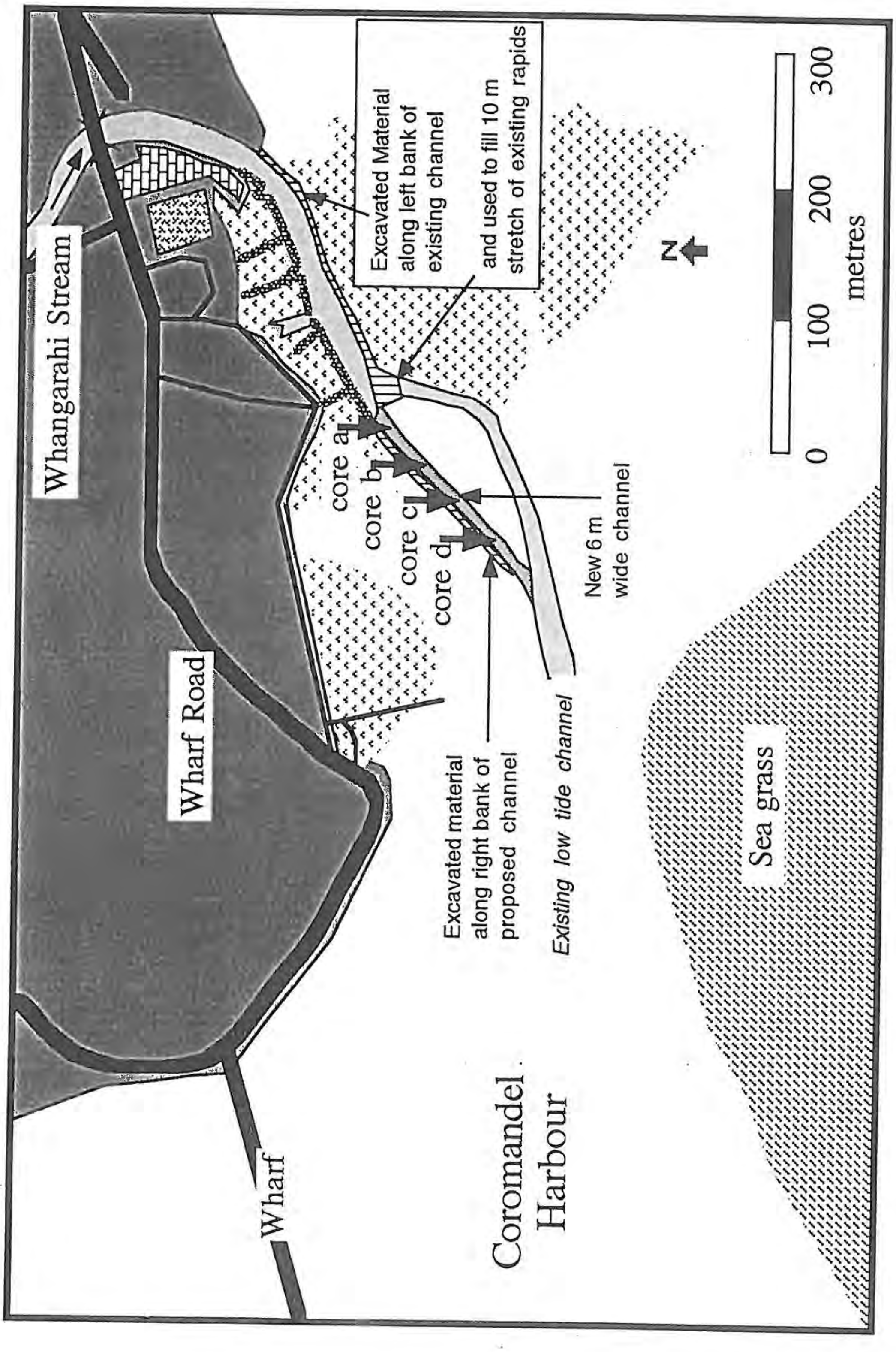


Figure 3. Sketch map of the lower Whangarahi Stream showing proposed development for channel realignment and position of cores taken for chemical analyses of material to be dredged.



4.0 Description of resident biota and sediment cores

4.1 Methods

4.1.1 Biological Communities

An aerial photograph of the area was used to prepare a provisional distribution map of major communities types in the area. This map was ground-truthed during a field inspection on the 18 th of January, 1991.

Estimates of abundance and cover for plants and animals living on the surface of the substratum relate to 5, 1 m x 1 m quadrats placed at random within each community type recognised.

Estimates of abundance for animals living below the surface of the substratum relate to 5 random 25 cm x 25 cm cores, 10 cm deep, which were removed from each substrate type recognised. Animals were then separated from cored material by sieving through a 0.5 mm mesh screen.

4.1.2 Sediment Cores

Samples for heavy metal and BOD analysis were taken with pre-split, taped, 5 cm internal diameter cores which were driven vertically into the sediment by hand at the localities indicated in Figure 3 (composite cores a, b, c and d). As the maximum depth of penetration achieved by coring was less than 1.5 m, a pit was excavated with a spade to describe sediment type to a depth of 1.5 m at each sampling site.

Each core was returned to the laboratory where it was split and described. All material in each core was fully mixed to provide a composite sample for heavy metal and BOD5 analyses.

Heavy metal analyses for Arsenic, Copper, Lead, Zinc and Mercury (mg / kg) were performed by R.J. Hill Laboratories in Hamilton.

Mercury was determined by cold vapour atomic absorption spectroscopy following a HCl / nitric acid digestion and oxidation with persulphate and permanganate.

Copper, lead and zinc were determined by flame atomic absorption spectroscopy from a portion of sample which had been air dried at 35°C, which had been gently ground to pass a 2 mm sieve, and which had then been digested in an *Aqua Regia* solution (2 : 1, HCL ; HNO_3).

Arsenic was determined by hydride generation atomic absorption spectroscopy following a further nitric / perchloric acid digest of an aliquot of the *Aqua Regia* digest.

Five day Biological Oxygen Demand analysis was performed by Tasmex Laboratories in Cambridge.

Sub-samples were mixed (suspended) with water in a closed system and water samples were subject to standard BOD_5 tests under standard conditions. Results have not been adjusted for salinity.

4.2 Results

4.2.1 Distribution of Biological Communities

The results of the mapping exercise for resident biological communities are summarised in Figure 2. Highly turbid water (in-water visibility of 0.10 m) in the area precluded an adequate visual assessment of fish species present.

4.2.1.1 Fauna of the low tide channel (see Figure 2)

The following animals were present in muddy silt (up to 1.0 m thick) in the low tide channel below the rapids: Perinereis sp., Marphysa depressa, Glycera americana, Owena fusiformis, Helice crassa, Cominella adspersa, Austrovenus (Chione) stutchburyi (juvenile), Paphies australis (juvenile), Cominella glandiformis and Amalda australis. No plants were recorded as present in very turbid water.

4.2.1.2. Mud Crab Community (see Figure 2 and Plate 3)

Helice crassa was abundant in deep sticky mud along the low tide channel and occurred with Perinereis sp., Marphysa depressa, Glycera americana, Owena fusiformis, Cominella adspersa, Chione stutchburyi (juvenile), Paphies australis (juvenile), and Cominella glandiformis.

4.2.1.3 Sea Grass Community (see Figure 2 and Plate 5)

Extensive meadows of Zostera novaezelandica were present to the south west of the Whangarahi Stream mouth. Associated animals included: Alpheus socialis, Pagurus novaezealandiae, Helice crassa, Owena fusiformis, Glycera americana, Hormosira banksii, Galeolaria hystrix, Macomoana liliana, Maoricolpus roseus, Dialoma subrostrata, Amphibola crenata, Cominella adspersa, Cominella glandiformis, Melagraphia aethiops, Balanoglossus australiensis, Paphies australis, Elminius modestus, Zeacumantus lutulentus, Chione stutchburyi, and Cladophora sp.

4.2.1.4 Shellfish Community (see Figure 2 and Plate 1)

Chione stutchburyi, Paphies australis and Cirolana arcuata, together with occasional worms, Helice crassa and Melagraphia aethiops colonised relatively coarse sediments in the area designated as a shellfish community in Figure 2.

4.2.1.5 Mangrove Community (see Figure 2 and Plates 3 and 4)

Avicennia marina var resinifera was present as an ecologically constructive sward in the areas illustrated in Figure 2. Amphibola crenata, Helice crassa, Pagurus novaezealandiae, Perinereis sp., Elminius modestus and Melagraphia aethiops occurred in this association but were not abundant. The algae Calaglossa lepieurii, Catenella nipae and Gracilaria secundata were present as epiphytes on emergent pneumatophores.

4.2.1.6 Mud Snail Community (see Figure 2 and Plate 3)

Amphibola crenata was very common on wet inter tidal muds at the localities indicated in Figure 2. Associated species included; Cominella adspersa, Edwardsia tricolor, Cominella glandiformis, Hormosira banksii, Galeolaria hystrix, Glycera americana, Dialome subrostrata, Helice crassa, Marphysa depressa, Paphies australis, Melagraphia aethiops, and Zeacumantus lutulentus.

4.2.1.7 Pacific Oyster Community (see Figure 2 and Plate 2)

Crassostrea gigas formed well-developed beds on the left bank of the low tide channel in the areas indicated in Figure 2. Gelidium, Chondria and Laurencia were common as epiphytes in this area and occurred with Melagraphia aethiops, Helice crassa, Chione stutchburyi, Paphies australis, Cirolana arcuata, and occasional worms

4.2.2 Sediment Cores

Sediment structure to be dredged along the route of the proposed channel is relatively complex with intermittent layers of coarse gravel interspersed with silt and sand to a depth of 1.5 m, together with occasional deposits of soft surficial mud in surface depressions (see Figure 4).

Core a penetrated to a depth of 350 mm before reaching an impenetrable gravel layer. There were stones and gravel at the surface of the core above a 10 cm deep horizon of muddy sand and a 20 cm deep layer of grey silty-mud. Pit A penetrated the gravel layer at the base of core a, under which a layer of predominantly muddy sand was sandwiched between a further layer of gravel at a depth of 110 centimetres from the sediment surface.

Core b penetrated through a sequenced of flowable brown mud, a more consolidated grey mud, and a relatively firm black mud on top of a sand layer at depths of 34 to 44 centimetres. The core only partially penetrated a gravel horizon at a depth of 44 to 50 centimetres. Pit B was constantly being invaded by flowable brown mud from the surface, but notwithstanding a further gravel horizon at a depth of 95 - 98 cm, and a sequenee of grey mud - gravel - grey mud between depths of 116 and 140 cm, was generally lined with relatively coarse sand.

Core c was a muddy sand profile with shells at the surface, interspersed with gravel horizons at 20 - 23 cm and at 41 - 46 cm, with grey silty-mud between depths of 23 - 37 cm and 103 - 115 centimetres.

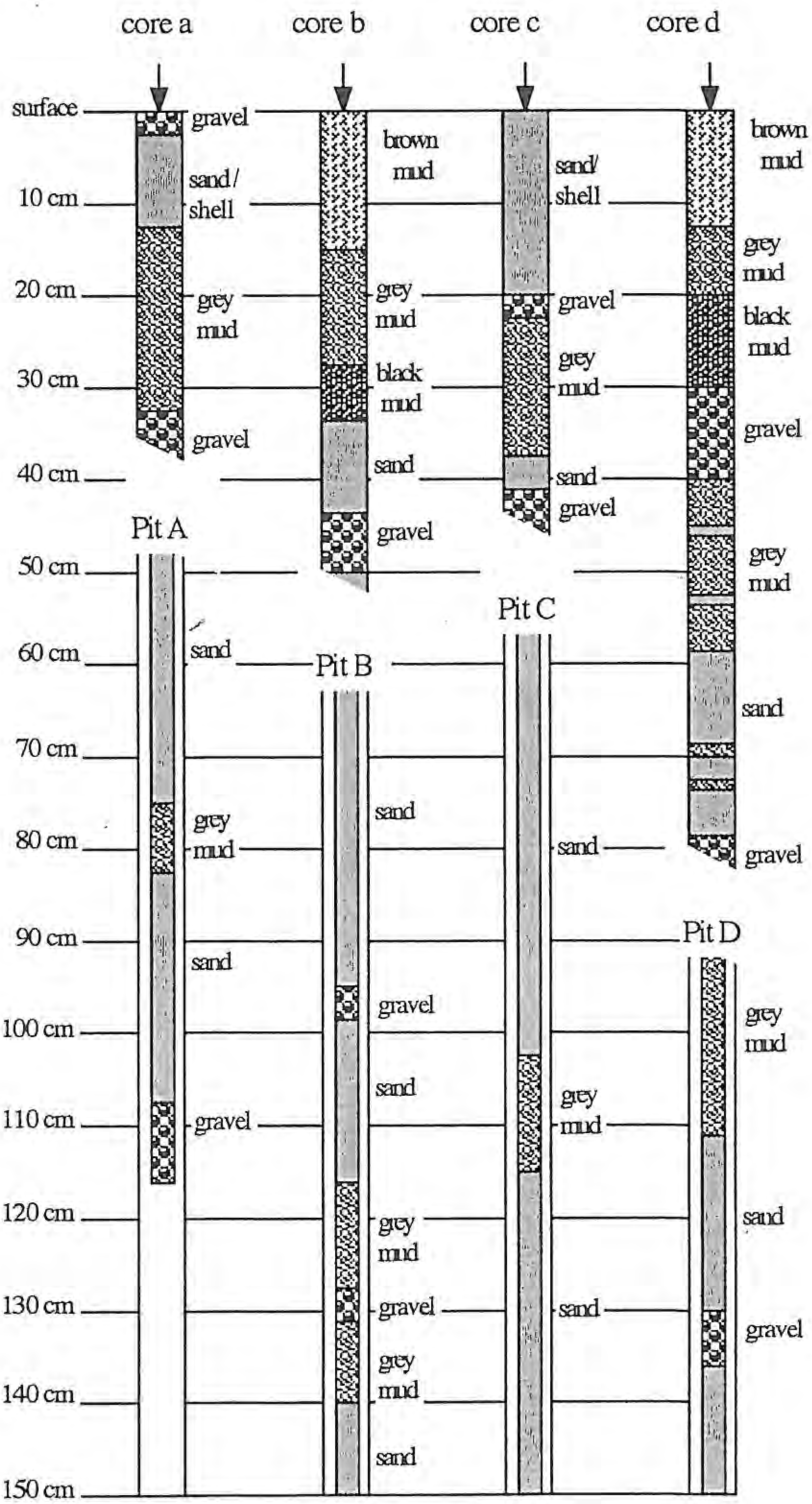
Core d was through a muddy site where the core passed through an upper gravel layer (30 - 40 cm deep) and penetrated to a second gravel layer at a depth of 80 centimetres. Above the upper gravel layer there was a clear sequence from brown to grey to black muds and between the two gravel layers there was an alternating sequence of sand and grey silty muds. Pit D, below the deeper gravel layer was lined with grey muds to a depth of 111 cm, over laying sand which was interrupted by a layer of gravel between depths of 130 and 136 centimetres.

Table 1. Selected chemical analyses for sediment cores a, b, s and d.

	composite core a	composite core b	composite core c	composite core d	threshold of concern EPA /OWRS*
Moisture (g/100 g)	34	47	38	48	
BOD5 (mg/kg)*	170	1,430	480	800	
Arsenic (mg/kg)	15.2	9.2	13.6	10.4	33
Copper (mg/kg)	15.2	8.2	9.6	8.7	136
Lead (mg/kg)	25	10	10	10	132
Zinc (mg/kg)	60	37	48	41	760
Mercury (mg/kg)**	0.18	0.10	0.04	0.09	0.8

* Zarba, C., 1989: Contaminated marine sediments: assessment and remediation
In: National perspective on sediment quality, National Research Council (US). Committee on contaminated marine sediments, Report No. 14-12-0001-30416 Washington DC, National Academy Press.
** not corrected for organic carbon
Note: these do not include materials identified in pits a - d as illustrated in Figure 4.

Figure 4 Texture of cores a, b, c and d in relation to depth (see Figure



5.0 Assessment of environmental effects of the proposed dredging and spoil disposal programme

Dredging operations can have an immediate and disruptive impact on habitats by removing resident biota and causing physical damage / disruption.

Where fine anoxic sediments are disturbed, suspension of particles together with biological and /or chemical oxygen demand, can degrade local water quality conditions. The most common short term consequences of dredging are associated with increased turbidity and decreased oxygen levels. Physical disturbance of anoxic sediments can also release toxic chemicals and plant nutrients into the water column.

Disposal of dredged spoil in or near water ways can physically smother resident plant and animal communities and can also degrade water quality.

Conversely, dredging is a very powerful restorative tool for water ways which have become silted-up or substantially in-filled. High suspended solid loadings are an obvious and undesirable feature of waters in the Coromandel Harbour and Furey's Creek does have a significant siltation problem.

5.1 Short-term dredging impacts

Dredging impacts in this instance will include physical removal and damage to plants and animals along the route of the proposed excavation and smothering of communities which are present at the disposal site for dredged material. Potential impacts include:

- physical disturbance and damage to surrounding communities,
- potential spillages of fuels and lubricants from machinery, and,
- local deterioration of water quality due to the disturbance and suspension of chemicals and fine particles from the proposed excavation.

Soft muddy sediments which are to be dredged (e.g. cores b and d) have a high oxygen depleting potential (800 - 1,430 mg / kg) if they were to be unduly mixed into receiving waters.

Arsenic, copper, lead, zinc and mercury were present at detectable levels in all four composite core samples analysed from the proposed channel. The concentrations of these potential toxins are lower than threshold concentrations published by the United States Environmental Protection Agency (see Table 1).

Threshold levels are those which, if exceeded, warrant a detailed investigation into the sensitivity of local biota to that particular chemical. Such investigations would include bioassay studies using local plants and animals as "indicator species" and a consideration of the chemical form ("biological availability") of such chemicals. Conversely, it follows that if the concentration of a particular chemical is below an established threshold concentration, it is unlikely to be toxic.

Unfortunately, threshold levels for "acceptable" or "safe" concentrations of heavy metals are less adequately researched for marine sediments than they are for water and there is a body of opinion that thresholds for marine sediments have not been adequately verified for New Zealand species and for New Zealand conditions. This situation has resulted in the current controversy with regard to dumping marine sediments dredged from the Ports of Auckland in the Hauraki Gulf[3].

[3] Decision No. A 131/91 by the Planning Tribunal, dated 16 December, 1991.

5.2 Long term impacts

The proposed cut passes through a shellfish community dominated by juvenile pipi (Paphies australis) and cockles (Austrovenus [Chione] stutchburyi). Ragworms, the sea slater Cirolana arcuata, the mud crab Helice crassa and the common spotted top shell Melagraphia aethiops are also common members of this association. The existing low tide channel is dominated by a community of marine worms.

Relative to mangrove and seagrass habitats, cockle and pipi associations have re-colonised areas disturbed by water jetting or suction dredging quite rapidly in Tairua and Whitianga Harbours.

Provided dredged sediments be placed in a similar inter tidal situation (e.g. by contouring the retired section of channel to an equivalent level) a cockle and pipi community would be expected to re-colonise this re-located material. Similarly, it is expected that existing fauna in the low tide channel will colonise the new bed of the proposed channel.

Should all sediments from the proposed channel be transferred to the retired section of the existing channel, it is expected the long term impact of proposed works would be a spatial juxtaposition of habitat type and community structure between the two sites.

Where it is necessary to re-locate contaminated marine sediments, land disposal has resulted in chemical transformation of potential toxins under changed environmental conditions and subsequent leaching of such materials from the disposal site. Ideally therefore, potentially contaminated materials should be relocated to a similar habitat with the minimum disturbance practicable.

The proposal to dispose of spoil along the left bank of the upstream river section (which is lined with mangroves) has potential to create local concern on the basis of:

a) current management principles for mangroves oppose the dumping of spoil or earth fill in such habitats. Indeed the draft Management Plan for Coromandel Harbour (3.2.1) advocates board walks rather than paths through mangrove areas on the west bank of the stream,

b) if dredged sediments are raised above their present level to created channel embankments, there may be concern that detectable levels of heavy metals have the potential to flux from these materials.

6.0 Mitigation options for actual and potential environmental effects of the proposed dredging and spoil disposal works

There is a clear need to improve boat access to Furey's Creek and the potential exists to directly transfer dredged material from the proposed to the retired channel. This should ensure the only long term impact of proposed works is a spatial juxtaposition of habitat type and community structure between the two sites.

Dredging and transfer technology between the proposed and existing channel which minimises mixing of dredged materials with receiving waters should contain the high high oxygen depletion potential of dredged material. Similarly by matching the final levels of material transferred between the proposed and retired section of stream channel, the potential for fluxing of heavy metals (although they may be at less than published thresholds of concern) should also be contained.

Deep mud banks which surround the dredging site will present problems of low tide access for dredging machinery. On the basis of national interest in the conservation of mangrove and seagrass communities which surround the area of proposed works (see Figure 1) barge or boat access for machinery at high tide may be preferable to access across mud flats at low tide.

Plate 1: View to south west from site V (see Figure 2) showing soft mud (mud crab habitat) on right bank of existing channel at low tide and coarse sediments (shellfish - pipi and cockle habitat) in foreground, 18 January, 1992.

Plate 2: View to north east from site W (see Figure 2) showing Pacific Oyster habitat on left bank of low tide channel and position of proposed channel (red line overlay) 18 January, 1992.

Plate 3: View to north from site X (see Figure 2) showing soft mud (mud snail habitat) in the upper inter tidal zone, surrounded by a mangrove community, 18 January, 1992.

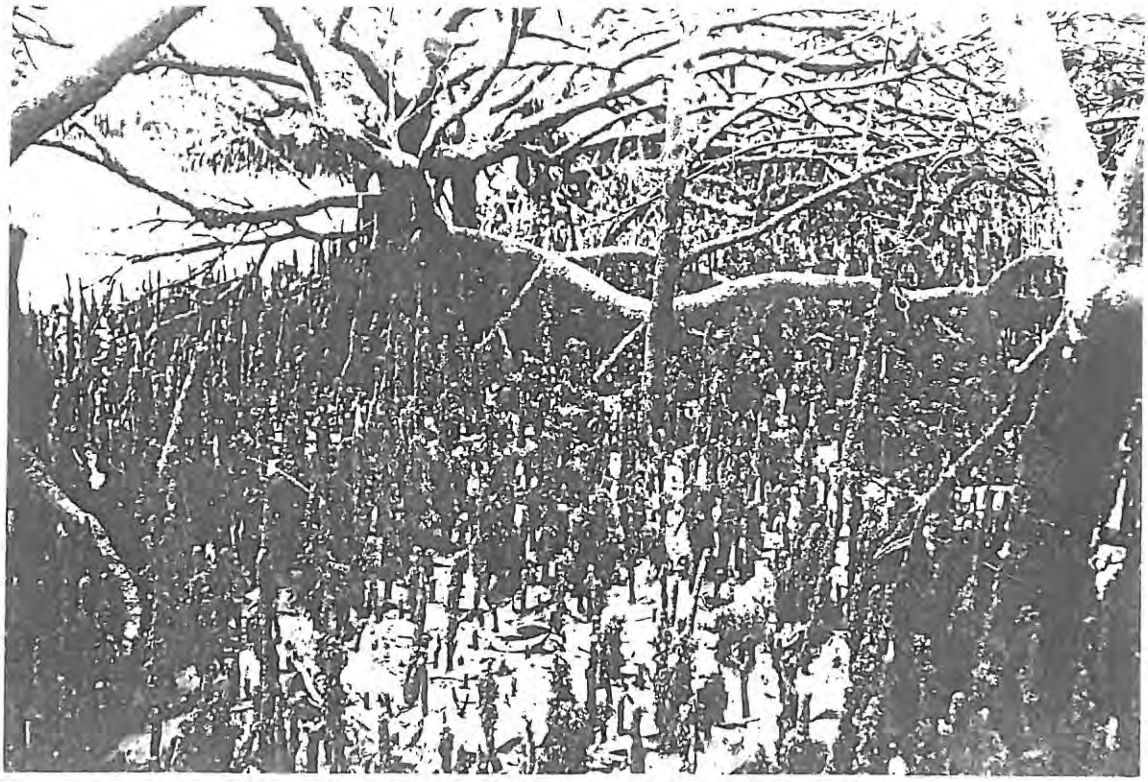


Plate 4: View under the canopy of mangrove community at site Y (see Figure 2) showing pneumatophores covered by the red alga Catenella nipae, 18 January, 1992.

Plate 5: View to south west from site Z (see Figure 2) showing sea grass community which is exposed at low tide, 18 January 1992.

Appendix C
Coromandel Boatshop Tank inspection (2010)

Appendix C
Coromandel Boatshop tank inspection (2010)

Phase I Assessment: Data/Site Visit Checklist
Chevron Boat Stop Divestment – New Zealand

This form is designed to identify the key data to be obtained when completing a Phase I Divestment Assessment at Chevron Boat Stop. This checklist aims to allow the user to identify a list of recognizable environmental conditions and limited environmental compliance factors which could have a bearing on the transfer of the property.

The information on this form should be completed with no lines left blank. If the question is not applicable, enter NA, if the information is unknown, enter UNKNOWN.

1.0 Facility Data:

Boat Stop Name: Coromandel Boat Stop

Chevron ID Number:

Land Owner:

Asset (Tanks, Pipe work etc) Owner:

Site Address: Wharf structure, off Ferry Road, Coromandel

City, Region:

Refer to *Figure 1* – Site Location Plan

2.0 Site Visit Data:

Date of Site Visit: 12/5/2010

Auditor(s): Carlos Rincón

Person(s) Interviewed: (1) Richard Williams, Harbour Master
(2) Nigel Strongman, supplies Caltex fuel to Whangapoua

Company Designation: (1) Environment Waikato

Phone number: (2) self-employed

While on site, take and log photographs of the site, its surroundings and any recognizable environmental conditions. Include in the photolog a series of general photographs of the site, including a photograph of the site entrance.

Annex A contains selected photographs taken during the site visit.

(1) position held for approximately nine years

3.0 Key Data to Obtain:

- **District and/or Regional Coastal Plans** including land and coastal zoning, sensitivity of receiving environment, rules pertaining to petroleum storage and handling etc
- **Regional/District Council Contaminated Site Search/Records**
- **Regional/District Council Consent/Records Search,** including Consents for petroleum structures within coastal/marine areas
- **Land Information Memorandum**
- **Certificate of Title for Land**
- Collect **Site Photographs** whilst conducting site visit
- **Detailed Site Layout Plan and Key Features** *(Figure 2)*
- **Current aerial photograph** (via Google) (*Figure 3*)
- **Two historical aerial photographs** (via NZAM) (*Figures 4 and 5*)
- **Site Photographs** (attached as *Annex A*)
- **Location Test Certificate** (attached as *Annex B*)
- **Stationary Container Test Certificate** for storage tanks (attached as *Annex B*)
- **Site's Emergency Procedures** and Evacuation Plan (attached as *Annex C*)
- Details of **fuel containment**, whilst unloading, in storage and in the transfer pipelines (sealed, bunded and drained)
- Details of **stormwater discharges** and comparison with Regional/District Council Rules
- **Wet Stock Reconciliation** Records (attached as *Annex D*)
- **Tank AND Pipeline Integrity Test and Maintenance** Results/Records (last 12 months worth) (attached as *Annex E*)
- **Field notes** from Observation / Groundwater Well Gauging Records and/or Soil Borings (attached as *Annex F*)
- **Previous Investigations,** if any
- Coastal Permit, if needed (typically for total capacity of 50,000 litres of more – does vary however) (*Annex G*)
- **Fire Service hazardous incidents and fire databases** (Annex H)
- **Environmental Risk Management Authority (ERMA) hazardous substances incident database** (Annex I)

4.0 Scope of Divestment Assessment

Refer to CVX Guidelines for Scope of Works for Environmental Assessment at Boat Stops

1. *If tanks and pipelines are aboveground and handling Diesel* – ***No intrusive assessment required***
2. *If tanks are above ground but pipelines are underground* – ***Limited intrusive assessment (only 3-4 soil borings up to 2-3m depth along the pipeline trajectory)***
3. *If the tanks are underground and less than 15 years old* – ***Limited intrusive assessment (Phase 1 + 2 soil borings to 1m below tank bottom (ca. 5 m)).***
4. *If the tanks are underground and more than 15 years old* – ***Assessment be done during tank removal.***

5.0 Land Zoning and Coastal Sensitivity

5.1 Land Zoning:

Review a copy of the Land Zoning Map from the relevant Council and describe the current land zoning of the site, and within a 300 m radius of the site:

Zoning of the site (state): Crown sea bed

Zoning of the site environs (300 m radius):

- ☐ Marina
- ☐ Coastal
- ☐ Industrial
- ☐ Marine Industrial
- ☐ Commercial and Retail
- ☐ Residential
- ☐ Mixed
- ☑ Other Village

On *Figure 2* identify the location of sensitive sites, scheduled sites, or special designations within a 300 m radius of the site:

- ☐ Marine and/or Foreshore Reserves
- ☐ Conservation areas
- ☐ Schools
- ☐ Iwi /community /Maimai designated areas
- ☐ Residential Properties
- ☐ Foreshore Reserves
- ☐ Other Reserves including estuaries etc
- ☐ Mixed
- ☑ Other Oyster Farms

5.2 Coastal Zoning:

Review the relevant Coastal Plan and describe sensitivities of the receiving environment, including whether the area is classified as a Significant Area.

The site is located in an area noted as Regionally Significant Coastal Environment. The Coromandel Harbour is classified as an Area of Significant Conservation Value.

6.0 Asset Information:

Date of refueling asset installation

1999

Historical tank removed in 1999 (installed 92) -double skinned (steel inner/fibreglass outer).

Date of CVX asset installation/ownership

Installed 1999

Prior use of location

Previous tank on-site.

The information below can be obtained during the site visit, through review of asset maintenance records (eg Fuel Quip Inspection Records), and from the CVX Asset Team.

Phone conversation with Malcolm Carlyon of Carlyon Civil Construction on 11.05.2010.

6.1 Existing Equipment - Tanks

Tank #	1	2	3
Size (Litres)	30,000L	—	—
Product stored	Diesel	—	—
Year installed	1999	—	—
Type (Steel, DWF, composite, other)	Double walled tank (fibreglass)	—	—
Above or Below Ground?	Below ground	—	—
Integrity Testing: date of last test	February 2010	—	—
Integrity Testing: date of next test	None scheduled	—	—
Integrity Testing Pass (Y/N)			

Tank #	1	2	3
Valid HSNO Stationary Container Test Certificate?	Not evident on site	—	—
State HSNO Stationary Container Test Certificate Expiry Date	Not evident on site	—	—
Secondary Containment: Y/N and describe	No concrete pit. Tank is double walled	—	—
Do all tank manholes and filling points have spill containments in acceptable working condition?	ERM did not inspect Carlyon Civil noted tank manway had water during integrity testing (rainwater?) manway appeared in good condition. Sump box around remote fill point as above.	—	—
Does the tank have a vent?	Yes		
Does the tank have a leak detector?	Yes - submersible pump in tank does have a detector	—	—
Does the tank have an overflow valve installed?	No	—	—

6.2 Existing equipment - Pipelines

Pipeline #	1 (Fill Line)	2 (Delivery Line)	3 (Vent Line)
Length (m)	2m ~~not~~ ~~remote~~	~28m	~10m
Product stored	Diesel	Diesel	—
Year installed	1999	1999	1999
Type (Steel, DWF, composite, other)	UPP (flexible plastic)	~~Steel~~ ? UPP	~~Steel~~ UPP (steel above ground)
Above Ground or Below Ground?	Below ground	Below ground	Below ground
Integrity/Pressure Testing, date of last test	Feb. 2010	30 April 2010	Feb 2010

Pipeline #	1 (Fill Line)	2 (Delivery Line)	3 (Vent Line)
Integrity/Pressure Testing Pass (Y/N)			
Integrity/Pressure Testing, date of next test.	None Scheduled	None Scheduled	None Scheduled
Secondary Containment – Y/N and describe	None - no concrete trench etc; 1	None	None
When not in use does product remain within the line?	Yes	Yes	—

1 Remote fill point is in a sump box.

6.3 Existing Equipment - Dispensers

Dispenser #	1	2	3
Is the dispenser pump hose free from cracks?	yes	—	—
Is the dispenser pump nozzle free from leakage?	yes	—	—
Is the dispenser securely mounted?	yes	—	—
Is the dispenser pump hose fitted with break-away couplings?	Shear valve would break if pump was severely knocked - this would shut off product flow.	—	—
Are the containment boxes under the dispensers in acceptable condition?	yes. burmed area around pumps, although containment volume is limited	—	—

6.4 Upgrades

Have any major upgrades or repairs to the equipment been undertaken in the past 5 years?

Date	Type Upgrade	Old Equipment (removed or left in place)
14 July 2009	Pipework in remote fill sump replaced due to corrosion. No sampling completed.	Removed

7.0 Known or Potential Environmental Releases

7.1 Wet Product Reconciliation

1. Are there product reconciliation records (Yes/~~No~~) refer Annex G

2. Method of product measurement (manual/automated system)

3. Note discrepancies in annual or other summary

Time Period	Product	Amount

7.2 Asset Maintenance Records

1. Review the past 12 months worth of asset maintenance records. Not available at Harbour Master office.
2. Was any free product, evidence of spills, or releases noted in the inspection records?
No losses reported by FuelQuip periodic maintenance from 2006 (Annex E)
3. Any other issues identified which are yet to be addressed?

Date of Inspection	Any product releases identified?	Any issues identified?	Comment

Date of Inspection	Any product releases identified?	Any issues identified?	Comment

7.3 Summary of Known and/or Reported Releases

Review any past agency reports or citations from:

1. Site management, ✓
2. Fire Service Fire and Spills Database, ✓
3. ERMA Hazardous Incidents Database, ✓
4. Regional Council Incidents/Consent files (as applicable). No records from EW of incidents (pers comm. M. Begbie)

Date	Description	Actions
Approx. 3 years ago	Approximately 17 litres spill from pump hose	Pump hose fixed by
	burst. Spill runoff to catchpit outside	Nigel Strongman
	bunded area. No product observed to	
	have escaped to	
	harbour waters	

7.4 Evidence of Releases (Site Visit)

During site visit, undertake visual inspection of pipe work (where practicable), dispenser area, tanker unloading area etc and note evidence of product release and/or other staining.

Date	Description	Actions
12/5/10	slight sheen around dispensers, potentially	
	from ~~unload~~ use dispensing practices	

Date	Description	Actions

7.5 Observation Well Gauging

During site visit, if within the scope, undertake gauging of the on-site observation wells (for underground tanks only). *Annex F* is to contain the field notes and gauging table.

During gauging was free product detected? Y/N 2 wells.

7.6 Previous Investigations

Have any investigative or remedial works been undertaken?	Y/N none recalled by both interviewees
If yes, answer the following:	
Did it include monitoring wells?	Y/N
Any reports or other information available?	Y/N

Environmental Reports			
Environmental Reports Available (Y/ N)	Date of Report	Author	Phase I/ II/ / GME / SVR
No reports available from Chevron records.			

Soil Testing				
Date of Testing	No. of Bores	Maximum Depth (m)	Analytes	Above Guidelines - Industrial/ Commercial

Groundwater Testing (On-Site)				
Date of Testing	No. on-site Wells	Free Phase Hydrocarbons Detected (Y/ N)	Analytes	Above Guidelines - Industrial/ Commercial

7.7 Potential Off-Site Sources

Identify Known or Potential Off-Site Hydrocarbon Sources within 300 meters of the property. List below and show on *Figure 2*. These could include: other refueling stops, industrial operations, and/or chemical or fuel storage. Include photographs within the *Photolog*.

Known or Potential Off-Site Source	Approximate Distance/Direction from Boat Stop (m)
None identified by site management	
(Harbour Master)	

8.0 Environmental Compliance

8.1 Consents, Permits and Licences

Does the site have all necessary regulatory licences and permits required for the area? List permit/licence type and expiration dates.

No stationary test certificate was observed at the site.

Note, in accordance with Schedule 1.5 of the Proposed New Zealand Coastal Policy Statement, 2008, which refers to structures in the coastal marine area used for storage or containment of petroleum, petroleum products or contaminants, any activity involving the erection of a structure or structures, including a pipeline, that will be used for the storage or containment of any petroleum, petroleum products, or contaminants, in quantities greater than or equal to 50,000 litres is a restricted coastal activity.

Does the structure require a Coastal Permit? and if so, is a current Permit held? Attach a copy as *Annex G.*

Refer Rule 16.4.18 of EW Plan.
No consent is required since stored volume is less than 50,000 L.

Are there any notices of violation, records of corrective actions and/or agency inspection issues? If so, please list.

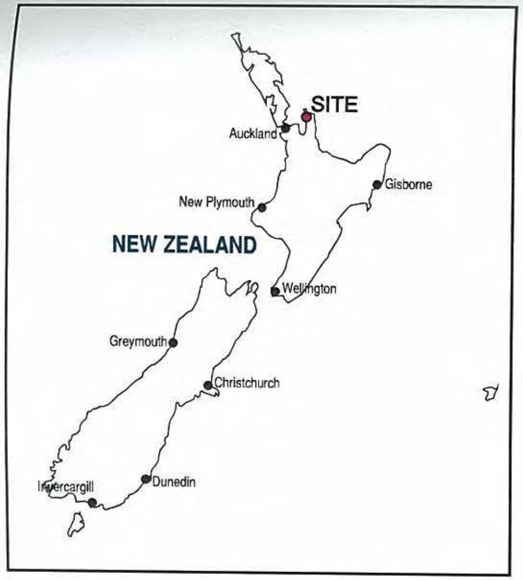
No.

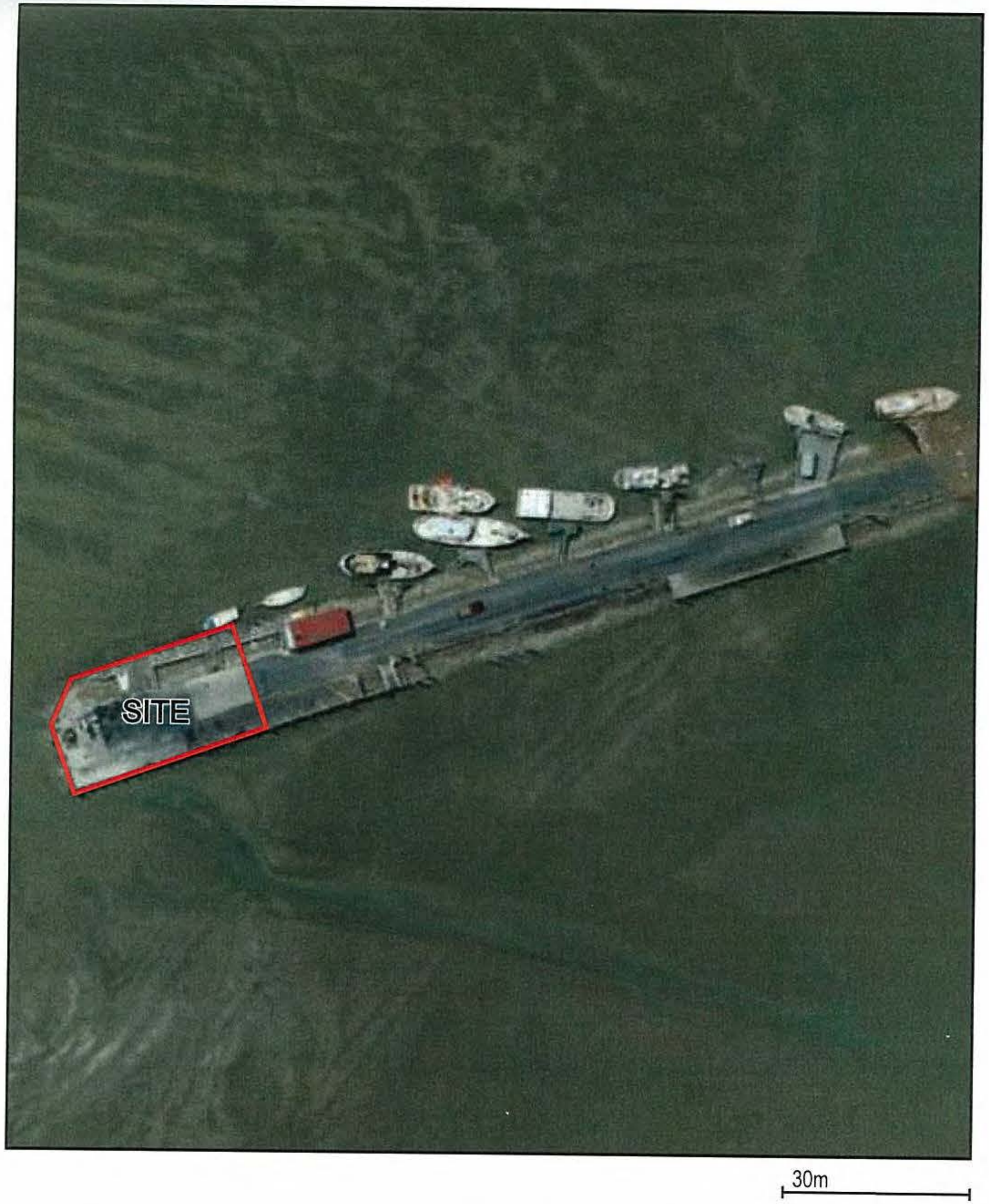
8.2 Stormwater Discharges

Stormwater	Yes	No
Is the area provided with hard stand?	✓	
Is this hard stand in good condition?	✓	
For areas where product is unloaded and stored - are these sealed and bunded – and with sufficient capacity?		✓ Dispenser area bunded but not sufficient. UST area not bunded
For the areas where product is unloaded and stored – is the stormwater and runoff collected and drained separately (eg to foul sewer, collected in tanks for removal by third party)? Or does this pass through a stormwater interceptor prior to discharge?	✓ Not sure.	
Has any stormwater quality monitoring been undertaken? If so, review results.	✓	According to Nigel, Aquaculture Industry monitors harbour water once a week
Are the stormwater grates clearly marked? visible, not marked		
Are all drainage grates and guards securely in place?	✓	
Are the vehicle access ways and the area of product unloading itself installed with cut off drains - which are not connected to the stormwater system?		✓
What provisions are there for spill containment, including stormwater catch grate covers etc. Any improvements needed? Spill kit on site, more equipment needed for large scale spill	✓	
Are there missing covers on UST dip points, fill points, etc.?		✓
Is the oil water separator in acceptable working condition?		✓ third stage with staining, odours, and old absorbent pads

8.3 Emergency Preparedness and Response

Emergency Preparedness and Response	Yes	No
Does the facility have an Emergency Response Plan?	✓	
Has this been updated within the past 12 months?	Unknown	
Has this plan been tested and validated and updated within the past 12 months?		✓
Has this plan received approval from the Local Fire Service?	Unknown	
Has this plan received approval from the Regional Council (as needed)?	Unknown	
Is the Emergency Shut Off Switch readily accessible?	✓	
Are the required type and number of fire extinguishers present on Site?		✓
Are the fire extinguishers serviced at least annually?	N/A	
Is the site provided with signage in compliance with legislative requirements?		✓
Is there a spill response kit on-site?	✓	





Legend

Approximate UPSS Location

Figure 1

Site Locality Map

Client:	Chevron New Zealand		
Project:	Coromandel Boat Stop		
Drawing No:	0116604a_01_R0		
Date:	11/05/2010	Drawing size:	A4
Drawn by:	EM	Reviewed by:	ER
Scale:	Refer to Scale Bar		

N

Maps and figures contained within this document may be based on third party data, may not be to scale and is intended for use as a guide only. ERM does not warrant the accuracy of any such maps or figures.

ERM New Zealand Ltd
Commerce House, Level 2, 13 Commerce Street
Auckland City 1143
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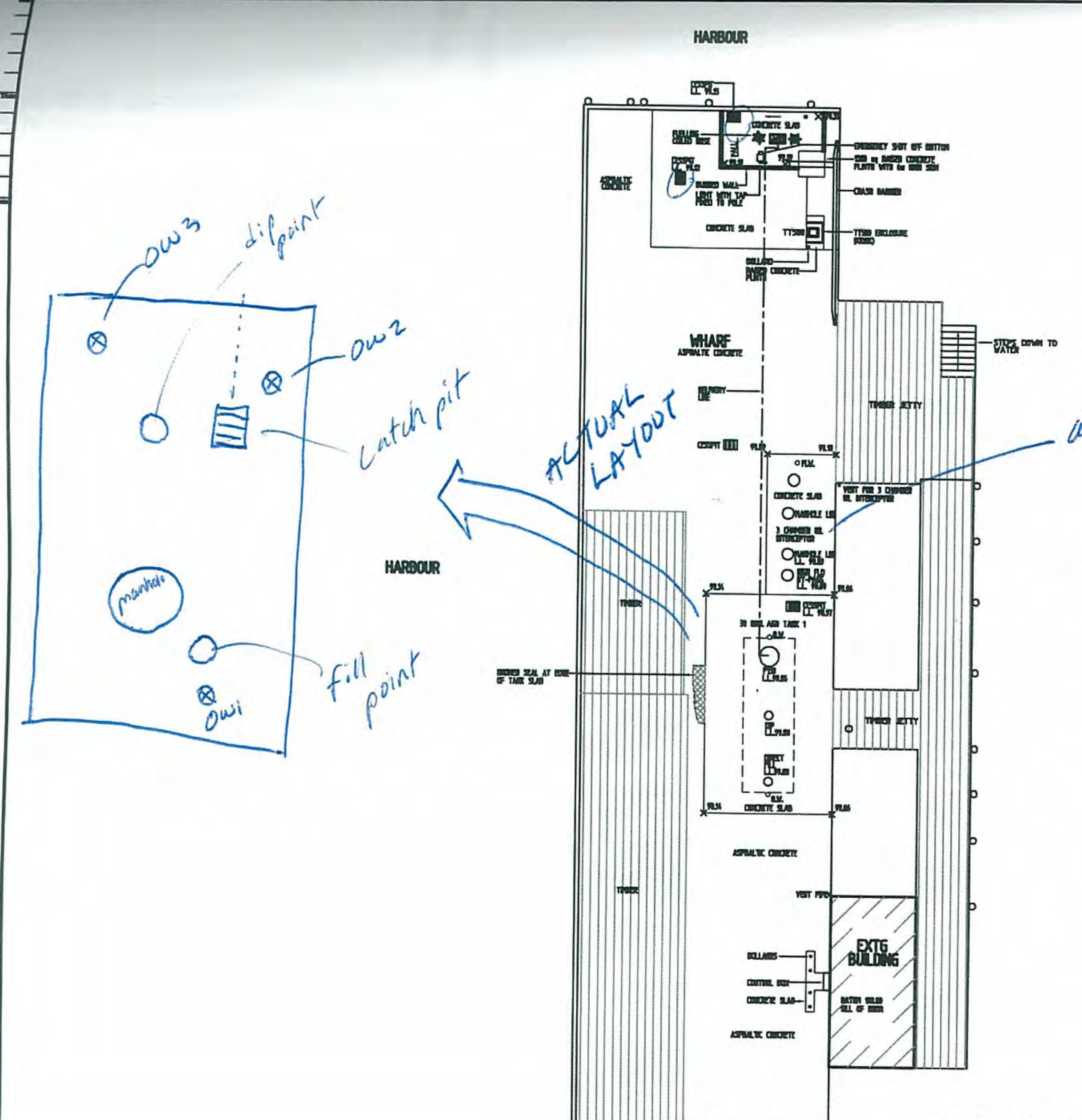
ERM

Figure 2A



PART SITE LAYOUT PLAN
SCALE 1:100 AT A1

THE FOLLOWING INFORMATION WAS TAKEN FROM CALTEX NEW ZEALAND JOB FILE.

TANK 30,000L U/G FIBREGLASS ON STEEL TANK
DELIVERY PIPEWORK - 50 N.B. FIBREGLASS DELIVERY LINE
LENGTH OF PIPELINE TO DISPENSER —— 24.00
PIPE AROUND HOSE REEL- 25Ø
LENGTH OF EACH FUELLING HOSE —— 2/30.00
∴ VOLUME OF FUEL IN PIPELINES —— 78 LITRES
ENVIRONMENTAL EMERGENCY RESPONSE SIGN LOCATION INSIDE KIOSK AROUND TT500

GENERAL NOTES

1. DO NOT SCALE OFF DRAWING.
2. CONTRACTOR SHALL VERIFY AND BE RESPONSIBLE FOR ALL DIMENSIONS ON SITE.
3. ARCHITECTS TO BE NOTIFIED OF ANY VARIATION BETWEEN SITE DIMENSIONS AND THOSE ON PLANS.
4. THIS DRAWING IS THE PROPERTY OF CALTEX OIL (NZ) LIMITED AND MUST NOT BE USED, COPIED OR REPRODUCED IN WHOLE OR PART WITHOUT PRIOR WRITTEN PERMISSION.
5. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL CONSULTANT'S DRAWINGS AND SPECIFICATIONS.

REV.	BY	DATE	DESCRIPTION OF CHANGE	CHKD	APP.

REVISIONS

CALTEX

BD DESIGN
23 Westminster Road
Mt. Eden, Auckland
Tel 64 09 638 7700
Fax 64 09 638 7708

APPROVALS	INITIALS	DATE

CAD DRAWING—DO NOT REVISE BY HAND

ENVIRONMENTAL PROGRAMME
COROMANDEL BOATSTOP
COROMANDEL

AS BUILT SITE PLAN

PLOT SCALE 1:1 | ORIG. SCALE 1:100 | CAD FILE \DWG\1900\1464\AB01

JOB No. 1464 | DRAWING No. 1464AB01

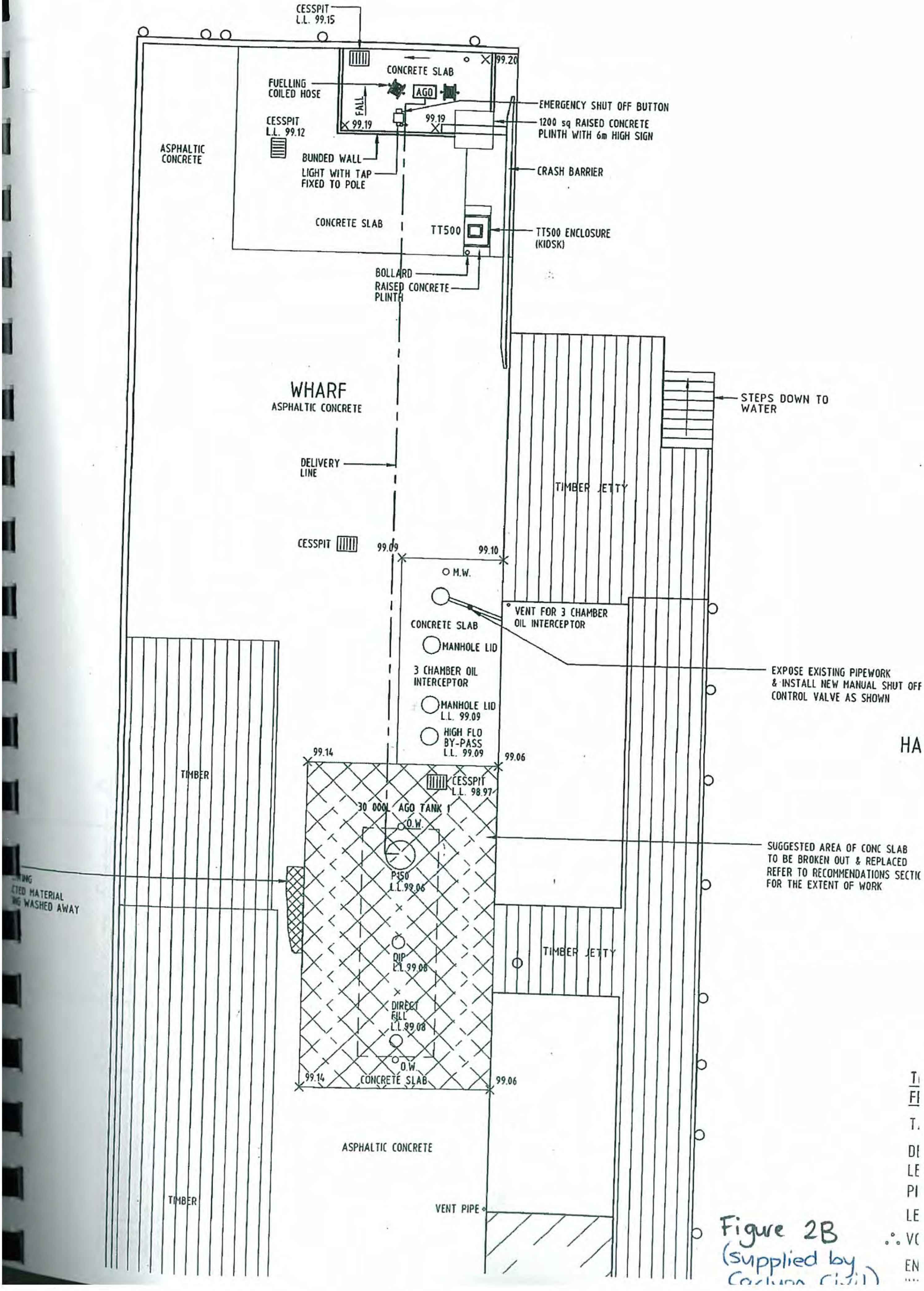
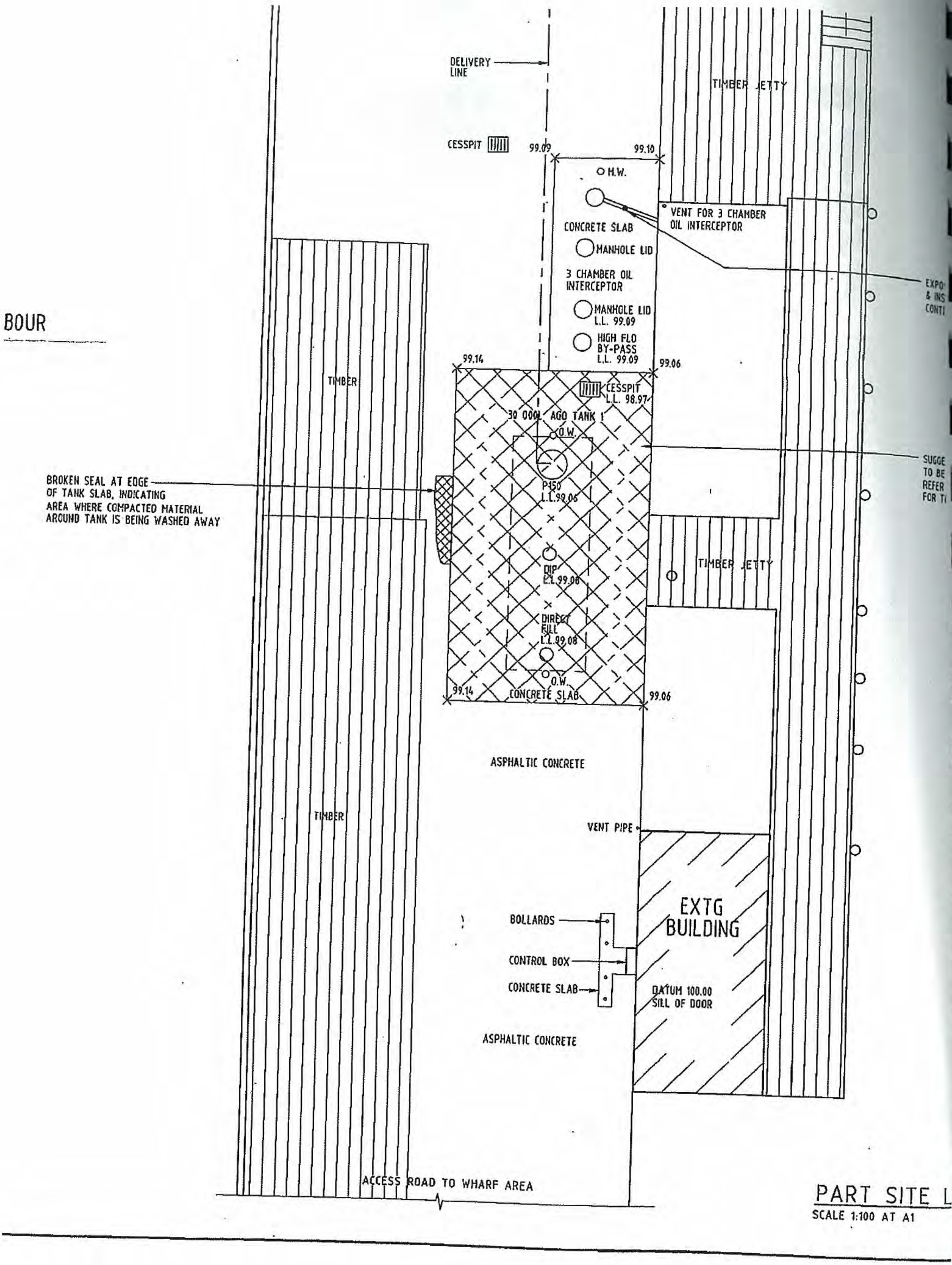


Figure 2B
(supplied by
Cardno Civil)



PART SITE L

SCALE 1:100 AT A1


Flown 29/03/1945
1:16000 scale
NZ Aerial Mapping Ltd
0800 880 690 www.nzam.com
Figure 3


Flown 09/02/1971
1:25000 scale
NZ Aerial Mapping Ltd
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Figure 4

Annex A

SITE PHOTOGRAPHS

(upto 9 photographs with captions)

Photograph 1

View of boat stop, looking to the west.

Photograph 2

View of the UST area, looking to the west.

Photograph 3

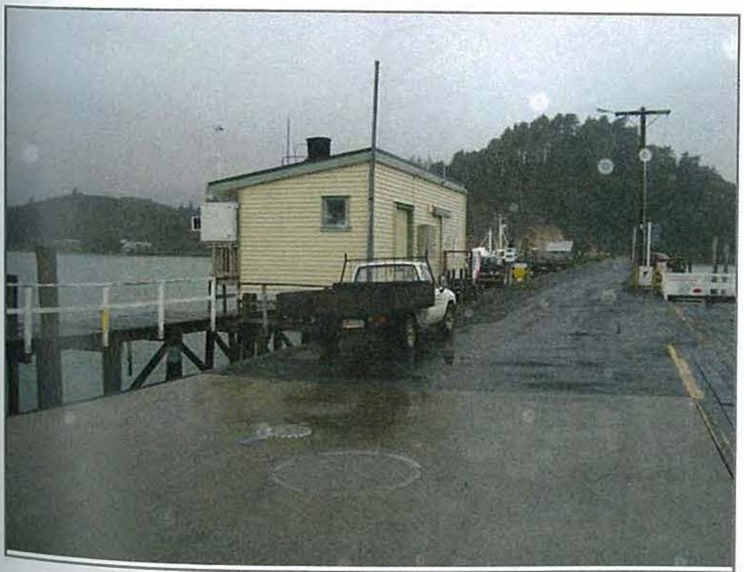
View of the three-stage interceptor, looking to the west. Interceptor shutoff vale in blue to the right.

Photograph 4

Interceptor runoff and shutoff valve, looking to the north.

Photograph 5

View of interceptor's third stage.



Photograph 6

View from the UST towards the Harbour Master's office and UST vent line, looking to the east.

Photograph 7

View of the unloading area looking to the north-west.

Photograph 8

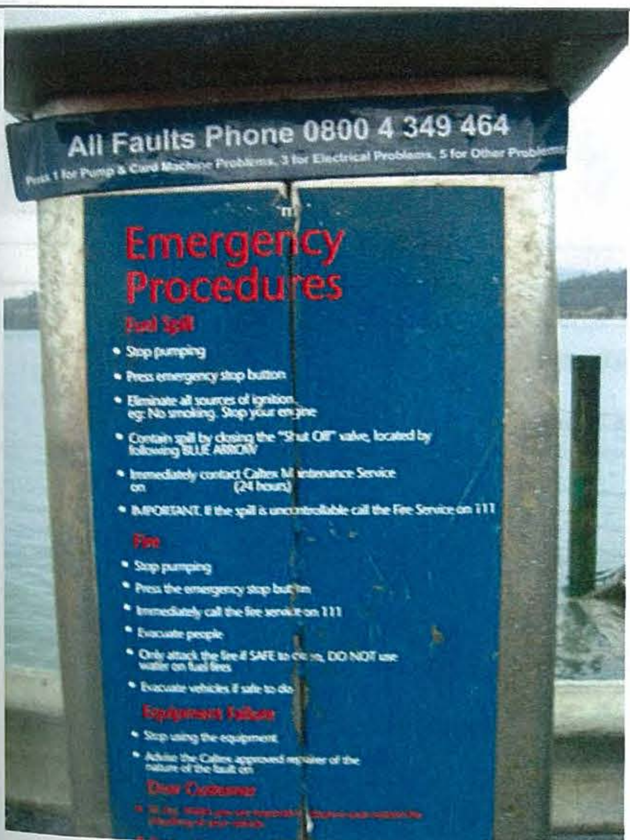
Dispensers area looking to the north.

Photograph 9

West end of the wharf, looking to the south-west.

Photograph 1

Dispenser shut-off.

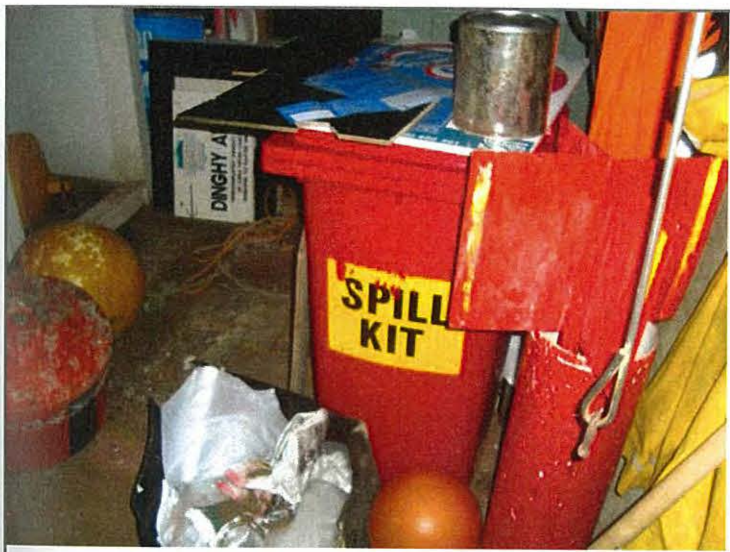


Photograph 2

Emergency procedures affixed to Pay Booth at the Site.

Photograph 3

Interceptor shut-off valve.



Photograph 4

Spill kit located inside in the Harbour Masters office.

Appendix D
Coromandel Wharf Sediment Assessment (PDP, 2012)

Appendix D
Coromandel Wharf
Sediment Assessment (PDP, 2012)

Auckland Wellington Christchurch

PATTLE DELAMORE PARTNERS LTD

Sediment Quality Assessment at Coromandel Wharf

Thames Coromandel District Council

***solutions** for your environment*

Sediment Quality Assessment at Coromandel Wharf

Prepared for

Thames Coromandel District Council

March 2012

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Quality Control Sheet

TITLE	**Sediment Quality Assessment at Coromandel Wharf**
CLIENT	Thames Coromandel District Council
VERSION	Final
DATE	March 2012
JOB REFERENCE	A02435106
SOURCE FILE(S)	A02435106 R001 A02435106 S004

Prepared by

SIGNATURE

Chris Foote Andrew Rumsby

Directed, reviewed and approved by

SIGNATURE

Keith Delamore

Executive Summary

Thames-Coromandel District Council (TCDC) has engaged Pattle Delamore Partners Limited (PDP) to undertake a survey of the sediment quality at Coromandel Wharf. The aim of this survey is to determine the concentration of metals within the sediment to ascertain the sediment quality around the Wharf.

This information will be used to consider proposals for new wharf facilities at Coromandel Wharf, which could involve dredging and disposal of the marine sediments.

Five discrete surface sediment samples (0-10 cm) and five sediment cores were collected at Coromandel Wharf. All samples were submitted to Hill Laboratories for analysis to determine total recoverable (US-EPA method 200.2) arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Five samples were also tested for antimony and organo tin compounds (dibutyltin, monobutyltin, tributyltin and triphenyltin).

The discrete surface samples tested for concentrations of organo tin and antimony taken near Coromandel Wharf found detectable levels of Dibutyltin and Tributyltin in one sample (COR-005). The dibutyltin and tributyltin concentration slightly exceeded ANZECC 2000 ISQG-low guidelines.

The concentration of mercury in all samples generally exceeded (with the exception of CMW03 0-0.02 0.131 mg/kg) the ANZECC (2000) ISQG-low guideline values with concentrations ranging from 0.196 mg/kg to 0.81 mg/kg. Furthermore three samples CMW01, CMW02 and CMW04 taken at 0.3-0.34 m, 0.4 m and 0.3 m depth below the sea bed respectively, exceeded the ANZECC (2000) ISQG-high guideline value for mercury with concentrations ranging from 1.52 mg/kg to 3.1 mg/kg.

The concentration of arsenic exceeded the ANZECC (2000) ISQG-low guideline values in three of the six discrete surface samples (COR003, COR004 and COR006) with values between 23 mg/kg and 27 mg/kg, with the other three samples close to the ISQG-low guideline value (20 mg/kg).

Other trace elements (cadmium, chromium, copper, nickel and zinc) analysed at Coromandel Wharf showed concentrations of these elements were lower than the relevant ANZECC (2000) ISQG-low guideline value.

As the general concentrations of arsenic and mercury in the sediment samples are between the ISQG-low and ISQG-high guideline values and three samples have contaminant concentrations above the ISQG-high guideline value, the sediments may be considered hazardous under the Waikato Regional Council Coastal Management Plan.

Table of Contents

Appendices

1.0 Introduction

Thames-Coromandel District Council (TCDC) has engaged Pattle Delamore Partners Limited (PDP) to undertake a survey of the sediment quality at Coromandel Wharf. The aim of this survey is to determine the concentration of metals within the sediment to ascertain the sediment quality around the Wharf.

Due to the shallow depth of the water at Coromandel Wharf, dredging of the marine sediment may be required and the dredging spoils need to be disposed of appropriately. To determine potential disposal options for the dredge spoils, an assessment of the marine sediments was undertaken. The Waikato Regional Council Coastal Management Plan prohibits the discharge of hazardous substances into the coastal marine area (unless it is allowed by Part 3 of the Resource Management (Marine Pollution) Regulations 1998). Therefore, the aim of this assessment is to determine the concentration of chemicals within the sediments and compare these values against the appropriate guideline values.

1.1 Target Elements of this Investigation

Sediment sampling previously undertaken within the area on behalf of Waikato Regional Council (Kim, 2007) identified that arsenic, cadmium, copper, lead, mercury and zinc are enriched within the surficial sediments. For this reason, these elements were targeted for this study. Antimony was also targeted as sediment sampling from around the Waihou River mouth had revealed elevated concentrations of this element. Organo tin compounds were also analysed in the discrete surface sediment samples collected from around the Coromandel Wharf because of the possible presence of boat anti-fouling paint residues in the sediment.

1.2 Project Aims

The aims of the project were to characterise the distribution of concentrations of selected elements in the sediment for the proposed Coromandel Wharf extension.

1.3 Sample Collection Methodology

The sampling was undertaken in accordance with the recommendations contained within the following documents:

- Handbook for Sediment Quality Assessment. Environmental Trust of Australia/CSIRO (2005).
- Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. US EPA, October 2001.

Five discrete surface sediment samples (0-10 cm) were collected using a hand trowel at low tide alongside the causeway and wharf structure at Coromandel Wharf. The hand trowel was decontaminated using sea water and Decon 90 between each sampling location in accordance with PDP procedures.

Five sediment cores were also collected at this location using an Ogeechee Sand Corer. The sand corer was operated from a small boat and collected core up to approximately 0.5 m depth below the sea bed. The sample location was recorded using high precision GPS. The samples were collected south west of the existing Coromandel Wharf near the location of the proposed works. The sample locations and positions are detailed in the appended Figure 1.

Once the core was collected the core was split into three sub samples (where possible) at approximately 0.0 m – 0.02 m depth, 0.02 m – 0.1 m depth and 0.4 m - 0.5 m depth and delivered to Hill laboratories using standard PDP chain of custody procedures.

1.4 Sample Analysis

All samples were submitted to Hill Laboratories for analysis to determine total recoverable (US-EPA method 200.2) arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc.

Five samples were also tested for antimony and organo tin compounds (dibutyltin, monobutyltin, tributyltin and triphenyltin).

2.0 Assessment Criteria

2.1 ANZECC Sediment Quality Guidelines

To establish the degree of risk of element concentrations to sediment-dwelling organisms and suitability for marine disposal, the results from this survey can be compared with Australian and New Zealand Environmental Conservation Council (ANZECC) interim guideline values for sediment quality (ISQGs) for the protection of aquatic ecosystems. For each trace element, there are two ANZECC (2000) guidelines for sediment quality.

- The lowest is the ISQG-low which represents a concentration below which adverse effects are unlikely. Concentrations of contaminants below the ISQG-low pose a low level of risk to aquatic organisms.
- The higher is the ISQG-high, which is a median level at which adverse effects are expected in half of the exposed organisms. Contaminant concentrations above the ISQG-high are interpreted as being likely to cause significant adverse effects on aquatic organisms.

Concentrations within the range of the ISQG-low and ISQG-high values are thought to pose a moderate level of risk to aquatic organisms. Concentrations of trace elements or other chemicals either below or above the ANZECC (2000) trigger values should not be thought of as safe or unsafe, but rather posing a lower or higher level of risk.

Values below the ISQG-low could mean that the elements are still toxic to aquatic organisms. This is because complex chemical mixtures of certain compounds are more toxic than their individual chemical components and the ANZECC (2000) guidelines are not designed to protect against those mixtures and because certain compounds such as mercury have specific chemical forms (methyl-mercury, ethyl-mercury) which bio-accumulate in organisms and bio-magnify up the food-chain. As bioaccumulation potential is site-specific, more detailed studies are required to assess such risks. Therefore, the guidelines are designed to be trigger values to indicate which sites may warrant closer investigation.

It should also be noted that the ANZECC (2000) guidelines are designed to protect aquatic ecosystems rather than to protect human health. Although ISQG-low values are lower than equivalent soil quality guidelines designed to protect human health, no conclusion should be made on the potential human health risk.

The Waikato Regional Coastal Plan (EW, 2005) prohibits the discharge of hazardous substances into the coastal marine area (unless it is allowed by Part 3 of the Resource Management (Marine Pollution) Regulations 1998). Therefore, for the purposes of this investigation, any contaminants found at concentrations above the ANZECC (2000) ISQG-high would be considered a hazardous substance, while contaminants at concentrations below the ANZECC (2000) ISQG-low would not be considered to be hazardous. Contaminants at concentrations above the ANZECC (2000) ISQG-low guideline but below the ANZECC (2000) ISQG-high may be considered to be hazardous substances, depending on site-specific factors (such as bioavailability), and so would be considered on an individual basis after a more site specific investigation has been undertaken to consider site-specific factors such as acid volatile sulphides, or porewater concentrations.

3.0 Results

3.1 General

Sampling locations are shown Figure 1 in Appendix A. The results of the analysis of these samples are shown in Table 1 and 2 in Appendix B and laboratory reports are attached in Appendix C.

3.2 Organo Tin and Antimony

The discrete surface samples tested for concentrations of organo tin compounds and antimony taken near Coromandel Wharf found detectable levels of dibutyltin and tributyltin (organo tin compounds) in one sample (COR-005) at a concentration slightly above the ISQG-low guideline value. The concentration of antimony was below the analytical detection limit of the laboratory in all samples.

3.3 Mercury and Arsenic

Overall the concentrations of mercury and arsenic in the samples collected at depth (>0.1m) contained higher concentrations of mercury (0.73-3.1mg/kg) and arsenic (27-38mg/kg) when compared to the surface samples (0-0.1m) (which had concentrations of mercury of 0.131-0.49mg/kg and arsenic of 13-28mg/kg).

A comparison between the sampling results with historical data collected from Coromandel Harbour by Hume and Dahm (1991) shows that the concentration of arsenic encountered at depth (>0.1m) was higher than the background concentrations of arsenic determined by Hume and Dahm in 1991.

The concentration of mercury in all samples generally exceeded (with the exception of CMW03 0-0.02 0.131 mg/kg) the ANZECC (2000) ISQG-low guideline values with concentrations ranging from 0.196 mg/kg to 0.81 mg/kg. Furthermore three samples CMW01, CMW02 and CMW04 taken below 0.3 m depth below the sea floor exceeded the ANZECC (2000) ISQG-high guideline value for mercury. The concentration of mercury in these samples ranged from 1.52 mg/kg to 3.1 mg/kg.

The concentration of arsenic exceeded the ANZECC (2000) ISQG-low guideline values in three of the six discrete surface samples and ten of the fifteen tested core samples with values between 23 mg/kg and 38 mg/kg. No samples tested exceeded the ANZECC (2000) ISQG-high guideline value for arsenic.

3.4 Cadmium, Chromium, Copper, Lead, Nickel and Zinc

There appears to be no clear spatial or depth relationship between the concentrations of cadmium, chromium, copper, lead, nickel and zinc in the sediment samples.

Generally cadmium, chromium, copper, lead, nickel and zinc analysed in the samples had concentrations lower than the relevant ANZECC (2000) ISQG-low guideline value.

A comparison between the sampling results with historical data collected from Coromandel Harbour by Hume and Dahm (1991) shows that a greater concentration of copper, zinc and lead was encountered in these sampling results, compared with the background concentrations of metals determined by Hume and Dahm in 1991.

4.0 Summary

At Coromandel Wharf the concentration of mercury in the five discrete surface samples taken near the wharf and causeway and the five cores taken from the southwest of the wharf generally exceeded (with the exception of CMW03 0-0.02) the ANZECC (2000) ISQG-low guideline values. Furthermore three of the samples exceeded the ANZECC (2000) ISQG-high guideline value for mercury and therefore may be considered as hazardous substances under the Environment Waikato Coastal Management Plan.

The concentration of arsenic exceeded the ANZECC (2000) ISQG-low guideline value (20mg/kg) in three of the six discrete surface samples (COR003, COR004 and COR006) with values between 23 mg/kg and 27 mg/kg, with the other three samples close to the value.

However all other trace elements (antimony, cadmium, chromium, copper, nickel and zinc) and organo tin showed concentrations of these elements were lower than the relevant ANZECC (2000) ISQG-low guideline values.

As the general concentrations of arsenic and mercury in the sediment samples are within the range of the ISQG-low and ISQG-high values and three samples have contaminant concentrations above the ISQG-high the sediments may be considered hazardous under the Waikato Regional Council Coastal Management Plan.

5.0 References

ANZECC (2000) ANZECC (2000) National Water Quality Management Strategy No. 4: Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environmental Conservation Council. And Agriculture and Resource Management Council of Australia and New Zealand.

Edbrooke, S. W. (Compiler) 2001 Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 Geological Map 3. Lower Hutt, New Zealand.

Hume, T. M. & Dahm (1991) An Investigation of the Effects of Polynesian and European Land Use on Sedimentation in Coromandel Estuaries. DSIR Marine and Freshwater Consultancy Report No. 6104.

Simpson, S., Batley, G., Chariton, A., Stauber, J., King, C., Chapman, J., Hyne, R. V., Gale, S. A., Roach, A. and Maher, W. (2005) Handbook for Sediment Quality Assessment. Environmental Trust.

U. S. EPA (2001) Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. United State Environmental Protection Agency, October, 2001.

Waikato Regional Council (2005) Waikato Regional Coastal Plan. Environment Waikato Policy Series 2005/06

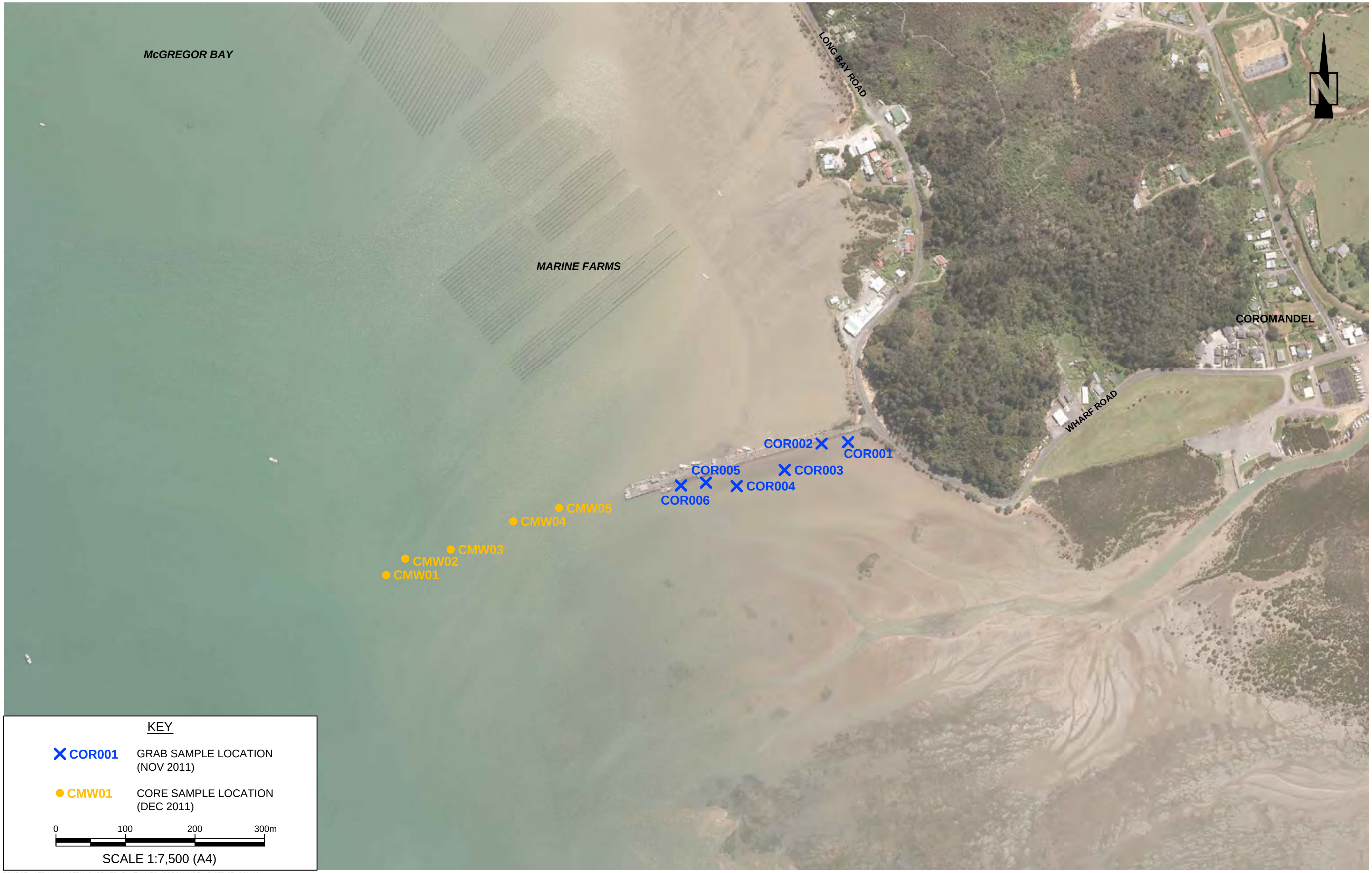
6.0 Limitations

This report has been prepared based on: visual observations of the site vicinity and 15 sediments samples from 5 sediment cores and 6 surficial sediment samples. All sediment samples were analysed by an analytical laboratory for a suite of seven heavy metals. Five samples were analysed for antimony and organo tin compounds. The site conditions as described in this report have been interpreted from, and are subject to, this information and its limitations and accordingly PDP does not represent that its interpretation accurately represents the full site conditions.

The laboratory test results provide an approximation of the concentration of chemical parameters and are subject to the inherent limitations of the laboratory techniques used for the tests.

The information contained within this report applies to sampling of sediment undertaken on the dates stated in this report, or if none is stated, the date of this report. With time, the site conditions and environmental standards could change so that the reported assessment and conclusions are no longer valid. Accordingly, the report should not be used to refer to site conditions and environmental standards applying at a later date without first confirming the validity of the report’s information at that time.

This report has been prepared by PDP on the specific instructions of Thames Coromandel District Council for the limited purposes described in the report. PDP accepts no liability to any other person for their use of or reliance on this report, and any such use or reliance will be solely at their own risk.



SOURCE: AERIAL IMAGERY SUPPLIED BY THAMES-COROMANDEL DISTRICT COUNCIL.

FIGURE 1 : COROMANDEL WHARF SAMPLING LOCATIONS

Appendix B
Tables

Table 1 Analysis of Core Samples Taken at Selected Locations at Coromandel Wharf, Coromandel

Sample Location		CMW01	CMW01	CMW01	CMW02	CMW02	CMW02	CMW03	CMW03	CMW03	Implied background concentration of metals in the Firth of Thames (Dahm & Humes, 1991)	Guidelines [1]	
Lab Number	Units	964071.43	964071.44	964071.47	964071.48	964071.49	964071.53	964071.54	964071.55	964071.57		ISQG-low	ISQG-high
Sample Depth	m	0-0.02	0.02-0.1	0.3-0.34	0-0.02	0.02-0.1	0.4	0-0.02	0.02-0.1	0.3			
Sediment type		SILT	SILT	SILT	SILT	SILT	SILT	SILT	SILT	SILT			
Mercury	mg/kg (dry weight)	0.22	0.21	3.1	0.22	0.23	1.52	0.131	0.26	0.73	-	0.15	1
Arsenic	mg/kg (dry weight)	16	14	38	14	17	28	13	23	27	6-16	20	70
Cadmium	mg/kg (dry weight)	< 0.10	< 0.10	0.12	< 0.10	< 0.10	0.11	< 0.10	< 0.10	0.14	-	1.5	10
Chromium	mg/kg (dry weight)	19	20	22	20	19	20	18	16	17	-	80	370
Copper	mg/kg (dry weight)	11	10	16	11	11	13	9	16	9	6-21	65	270
Lead	mg/kg (dry weight)	19.1	17.4	21	18.7	19.1	15.3	11.9	30	11.5	8-18	50	220
Nickel	mg/kg (dry weight)	6	6	7	6	6	6	5	6	6	-	21	52
Zinc	mg/kg (dry weight)	59	58	67	65	64	54	53	98	47	36-78	200	410

Table 1 Analysis of Core Samples Taken at Selected Locations at Coromandel Wharf, Coromandel

Sample Location		CMW04	CMW04	CMW04	CMW05	CMW05	CMW05				Implied background concentration of metals in the Firth of Thames (Dahm & Humes, 1991)	Guidelines [1]	
Lab Number	Units	964071.58	964071.59	964071.62	964071.63	964071.64	964071.66					ISQG-low	ISQG-high
Sample Depth	m	0-0.2	0.02-0.1	0.3	0-0.02	0.02-0.1	0.3-0.4						
Sediment type		SILT	SILT	SILT	SILT	SILT	SILT						
Mercury	mg/kg (dry weight)	0.21	0.22	1.9	0.25	0.196	0.81				-	0.15	1
Arsenic	mg/kg (dry weight)	28	23	35	25	27	31				6-16	20	70
Cadmium	mg/kg (dry weight)	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.14				-	1.5	10
Chromium	mg/kg (dry weight)	14	15	15	15	14	14				-	80	370
Copper	mg/kg (dry weight)	20	18	18	17	15	14				6-21	65	270
Lead	mg/kg (dry weight)	31	34	25	28	31	25				8-18	50	220
Nickel	mg/kg (dry weight)	5	5	5	5	5	5				-	21	52
Zinc	mg/kg (dry weight)	93	94	80	87	91	95				36-78	200	410

Notes. 1 ANZECC & ARMCANZ (2000) National Water Quality Management Strategy No. 4: Australian and New Zealand Guidelines for Fresh and Marine Water Quality

(yellow) Sample exceeds ANZECC (2000) ISQG-low guideline value

(red) Sample exceeds ANZECC (2000) ISQG-high guideline value

Table 2 Analysis of Discrete Surface Samples Taken at Selected Locations at Coromandel Wharf, Coromandel

Sample Location		COR001	COR002	COR003	COR004	COR005	COR006	Implied background concentration of metals in the Firth of Thames (Dahm & Humes, 1991)	Guidelines [1]	
Lab Number	Units	957206.9	957206.10	957206.11	957206.12	957206.13	957206.14		ISQG-low	ISQG-high
Sediment type		SILT	SILT	SILT	SILT	SILT	SILT			
Antimony	mg/kg (dry weight)	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	-	2	25
Mercury	mg/kg (dry weight)	0.32	0.31	0.34	0.42	0.49	0.35	-	0.15	1
Arsenic	mg/kg (dry weight)	19	19	23	27	19	23	6-16	20	70
Cadmium	mg/kg (dry weight)	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	-	1.5	10
Chromium	mg/kg (dry weight)	12	11	12	13	15	23	-	80	370
Copper	mg/kg (dry weight)	14	11	10	19	26	26	6-21	65	270
Lead	mg/kg (dry weight)	18.6	20	23	32	26	24	8-18	50	220
Nickel	mg/kg (dry weight)	4	4	4	5	6	7	-	21	52
Zinc	mg/kg (dry weight)	78	82	101	119	84	95	36-78	200	410
Dibutyltin (as Sn)	mg/kg (dry weight)	< 0.005	< 0.005	< 0.005	< 0.005	0.020	< 0.005	-	-	-
Monobutyltin (as Sn)	mg/kg (dry weight)	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	-	-	-
Tributyltin (as Sn)	mg/kg (dry weight)	< 0.004	< 0.004	< 0.004	< 0.004	0.032	< 0.004	-	0.005	0.07
Triphenyltin (as Sn)	mg/kg (dry weight)	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	-	-	-

Notes. 1 ANZECC & ARMCANZ (2000) National Water Quality Management Strategy No. 4: Australian and New Zealand Guidelines for Fresh and Marine Water Quality

(yellow)	Sample exceeds ANZECC (2000) ISQG-low guideline value
(red)	Sample exceeds ANZECC (2000) ISQG-high guideline value

Appendix C

Lab Reports

Hill Laboratories
BETTER TESTING BETTER RESULTS

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Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	957206 SPv5
Contact:	A Rumsby	**Date Registered:**	29-Nov-2011
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	09-Jan-2012
	PO Box 9528	**Quote No:**	47162
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02435104
		Submitted By:	A Rumsby

Sample Type: Sediment

Sample Name:		COR001 27-Nov-2011	COR002 27-Nov-2011	COR003 27-Nov-2011	COR004 27-Nov-2011	COR005 27-Nov-2011
Lab Number:		957206.9	957206.10	957206.11	957206.12	957206.13
Individual Tests						
Dry Matter	g/100g as rcvd	65	70	70	70	56
Total Recoverable Antimony	mg/kg dry wt	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	19	20	23	27	19
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	12	11	12	13	15
Total Recoverable Copper	mg/kg dry wt	14	11	10	19	26
Total Recoverable Lead	mg/kg dry wt	18.6	20	23	32	26
Total Recoverable Mercury	mg/kg dry wt	0.32	0.31	0.34	0.42	0.49
Total Recoverable Nickel	mg/kg dry wt	4	4	4	5	6
Total Recoverable Zinc	mg/kg dry wt	78	82	101	119	84
Tributyl Tin Trace in Soil samples by GCMS						
Dibutyltin (as Sn)	mg/kg dry wt	< 0.005	< 0.005	< 0.005	< 0.005	0.020
Monobutyltin (as Sn)	mg/kg dry wt	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007
Tributyltin (as Sn)	mg/kg dry wt	< 0.004	< 0.004	< 0.004	< 0.004	0.032
Triphenyltin (as Sn)	mg/kg dry wt	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003

Sample Name:		COR006 27-Nov-2011				
Lab Number:		957206.14				
Individual Tests						
Dry Matter	g/100g as rcvd	57	-	-	-	-
Total Recoverable Antimony	mg/kg dry wt	< 0.4	-	-	-	-
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	23	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	23	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	26	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	24	-	-	-	-
Total Recoverable Mercury	mg/kg dry wt	0.35	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	7	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	95	-	-	-	-
Tributyl Tin Trace in Soil samples by GCMS						
Dibutyltin (as Sn)	mg/kg dry wt	< 0.005	-	-	-	-
Monobutyltin (as Sn)	mg/kg dry wt	< 0.007	-	-	-	-
Tributyltin (as Sn)	mg/kg dry wt	< 0.004	-	-	-	-
Triphenyltin (as Sn)	mg/kg dry wt	< 0.003	-	-	-	-

S U M M A R Y O F M E T H O D S

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	9-14
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	9-14
Tributyl Tin Trace in Soil samples by GCMS	Solvent extraction, ethylation, SPE cleanup, GC-MS SIM analysis. Tested on dried sample	-	9-14
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	9-14
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	9-14
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	9-14

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

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Web www.hill-labs.co.nz

A N A L Y S I S R E P O R T

Client:	Pattle Delamore Partners Ltd	**Lab No:**	964071 SPv4
Contact:	A Rumsby	**Date Registered:**	20-Dec-2011
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	15-Mar-2012
	PO Box 9528	**Quote No:**	47394
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02435105
		Submitted By:	Chris Foote

Sample Type: Soil

Sample Name:		CMW01 0-0.02 15-Dec-2011	CMW01 0.02-0.1 15-Dec-2011	CMW01 0.3-0.34 15-Dec-2011	CMW02 0-0.02 15-Dec-2011	CMW02 0.02-0.1 15-Dec-2011
Lab Number:		964071.43	964071.44	964071.47	964071.48	964071.49
Individual Tests						
Dry Matter	g/100g as rcvd	56	-	-	61	-
Total Recoverable Mercury	mg/kg dry wt	0.22	0.21	3.1	0.22	0.23
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	16	14	38	14	17
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	0.12	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	19	20	22	20	19
Total Recoverable Copper	mg/kg dry wt	11	10	16	11	11
Total Recoverable Lead	mg/kg dry wt	19.1	17.4	21	18.7	19.1
Total Recoverable Nickel	mg/kg dry wt	6	6	7	6	6
Total Recoverable Zinc	mg/kg dry wt	59	58	67	65	64
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Acenaphthylene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Anthracene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Benzo[a]anthracene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Chrysene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Fluoranthene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Fluorene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Naphthalene	mg/kg dry wt	< 0.5	-	-	< 0.4	-
Phenanthrene	mg/kg dry wt	< 0.09	-	-	< 0.08	-
Pyrene	mg/kg dry wt	< 0.09	-	-	< 0.08	-

Sample Name:		CMW02 0.4 15-Dec-2011	CMW03 0-0.02 15-Dec-2011	CMW03 0.02-0.1 15-Dec-2011	CMW03 0.3 15-Dec-2011	CMW04 0-0.02 15-Dec-2011
Lab Number:		964071.53	964071.54	964071.55	964071.57	964071.58
Individual Tests						
Dry Matter	g/100g as rcvd	-	66	-	-	79
Total Recoverable Mercury	mg/kg dry wt	1.52	0.131	0.26	0.73	0.21
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	28	13	23	27	28
Total Recoverable Cadmium	mg/kg dry wt	0.11	< 0.10	< 0.10	0.14	< 0.10

Sample Type: Soil						
Sample Name:		CMW02 0.4 15-Dec-2011	CMW03 0-0.02 15-Dec-2011	CMW03 0.02-0.1 15-Dec-2011	CMW03 0.3 15-Dec-2011	CMW04 0-0.02 15-Dec-2011
Lab Number:		964071.53	964071.54	964071.55	964071.57	964071.58
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Chromium	mg/kg dry wt	20	18	16	17	14
Total Recoverable Copper	mg/kg dry wt	13	9	16	9	20
Total Recoverable Lead	mg/kg dry wt	15.3	11.9	30	11.5	31
Total Recoverable Nickel	mg/kg dry wt	6	5	6	6	5
Total Recoverable Zinc	mg/kg dry wt	54	53	98	47	93
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Acenaphthylene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Anthracene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Benzo[a]anthracene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Benzo[a]pyrene (BAP)	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Benzo[g,h,i]perylene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Benzo[k]fluoranthene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Chrysene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Dibenzo[a,h]anthracene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Fluoranthene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Fluorene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Naphthalene	mg/kg dry wt	-	< 0.4	-	-	< 0.4
Phenanthrene	mg/kg dry wt	-	< 0.08	-	-	< 0.07
Pyrene	mg/kg dry wt	-	< 0.08	-	-	< 0.07

Sample Name:		CMW04 0.02-0.1 15-Dec-2011	CMW04 0.3 15-Dec-2011	CMW05 0-0.02 15-Dec-2011	CMW05 0.02-0.1 15-Dec-2011	CMW05 0.3-0.4 15-Dec-2011
Lab Number:		964071.59	964071.62	964071.63	964071.64	964071.66
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	76	-	-
Total Recoverable Mercury	mg/kg dry wt	0.22	1.90	0.25	0.196	0.81
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	23	35	25	27	31
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	0.14
Total Recoverable Chromium	mg/kg dry wt	15	15	15	14	14
Total Recoverable Copper	mg/kg dry wt	18	18	17	15	14
Total Recoverable Lead	mg/kg dry wt	34	25	28	31	25
Total Recoverable Nickel	mg/kg dry wt	5	5	5	5	5
Total Recoverable Zinc	mg/kg dry wt	94	80	87	91	95
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	-	-	< 0.07	-	-
Acenaphthylene	mg/kg dry wt	-	-	< 0.07	-	-
Anthracene	mg/kg dry wt	-	-	< 0.07	-	-
Benzo[a]anthracene	mg/kg dry wt	-	-	< 0.07	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	-	-	< 0.07	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	-	-	< 0.07	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	-	-	< 0.07	-	-
Benzo[k]fluoranthene	mg/kg dry wt	-	-	< 0.07	-	-
Chrysene	mg/kg dry wt	-	-	< 0.07	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	-	-	< 0.07	-	-
Fluoranthene	mg/kg dry wt	-	-	< 0.07	-	-
Fluorene	mg/kg dry wt	-	-	< 0.07	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	-	-	< 0.07	-	-
Naphthalene	mg/kg dry wt	-	-	< 0.4	-	-
Phenanthrene	mg/kg dry wt	-	-	< 0.07	-	-
Pyrene	mg/kg dry wt	-	-	< 0.07	-	-

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	43-44, 47-49, 53-55, 57-59, 62-64, 66
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	43-44, 47-49, 53-55, 57-59, 62-64, 66
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample.	-	43, 48, 54, 58, 63
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	43, 48, 54, 58, 63
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	43-44, 47-49, 53-55, 57-59, 62-64, 66
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.010 mg/kg dry wt	43-44, 47-49, 53-55, 57-59, 62-64, 66

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Martin Cowell - BSc (Chem)
Client Services Manager - Environmental Division

Appendix E
Laboratory Certificates of Analyses

Appendix E
Laboratory certificates of analyses

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Aurecon	**Lab No:**	1205618 SPv1
Contact:	R Griffiths	**Date Registered:**	21-Nov-2013
	C/- Aurecon	**Date Reported:**	06-Dec-2013
	PO Box 2292	**Quote No:**	
	TAURANGA 3140	**Order No:**	237899
		Client Reference:	237899 Coromandel
		Submitted By:	R Griffiths

Sample Type: Soil

Sample Name:		AU13-001 19-Nov-2013	AU13-002 19-Nov-2013	AU13-003 19-Nov-2013	AU13-004 19-Nov-2013	AU13-005 19-Nov-2013
Lab Number:		1205618.1	1205618.2	1205618.3	1205618.4	1205618.5
Individual Tests						
Dry Matter	g/100g as rcvd	62	81	76	72	60
Total Recoverable Antimony	mg/kg dry wt	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total Recoverable Selenium	mg/kg dry wt	< 20	< 20	< 20	< 20	< 20
Total Recoverable Vanadium	mg/kg dry wt	< 100	< 100	< 100	< 100	< 100
Total Cyanide*	mg/kg dry wt	< 0.10	0.14	< 0.10	< 0.10	< 0.10
pH*	pH Units	8.0	8.3	8.3	8.2	8.1
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	26	25	24	25	28
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	18	14	12	15	19
Total Recoverable Copper	mg/kg dry wt	21	20	17	19	21
Total Recoverable Lead	mg/kg dry wt	34	24	25	56	29
Total Recoverable Mercury	mg/kg dry wt	0.16	< 0.10	< 0.10	0.22	0.20
Total Recoverable Nickel	mg/kg dry wt	7	6	7	6	7
Total Recoverable Zinc	mg/kg dry wt	90	80	74	93	89

Sample Name:		AU13-006 19-Nov-2013	AU13-007 19-Nov-2013	AU13-008 19-Nov-2013	AU13-009 19-Nov-2013	AU13-010 19-Nov-2013
Lab Number:		1205618.6	1205618.7	1205618.8	1205618.9	1205618.10
Individual Tests						
Dry Matter	g/100g as rcvd	70	46	46	69	37
Total Recoverable Antimony	mg/kg dry wt	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total Recoverable Selenium	mg/kg dry wt	< 20	< 20	< 20	< 20	< 20
Total Recoverable Vanadium	mg/kg dry wt	< 100	< 100	< 100	< 100	< 100
Total Cyanide*	mg/kg dry wt	< 0.10	0.50	< 0.10	0.64	< 0.10
pH*	pH Units	8.1	8.0	7.7	8.3	7.9
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	28	20	18	21	20
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	< 0.10	0.12	< 0.10
Total Recoverable Chromium	mg/kg dry wt	16	24	21	14	31
Total Recoverable Copper	mg/kg dry wt	21	19	14	12	23
Total Recoverable Lead	mg/kg dry wt	59	26	20	22	24
Total Recoverable Mercury	mg/kg dry wt	0.18	0.18	0.24	0.18	0.23
Total Recoverable Nickel	mg/kg dry wt	6	7	6	5	9
Total Recoverable Zinc	mg/kg dry wt	87	78	66	81	91

Analyst's Comments

Sample 3 for Total CN, fine particles used in distillation. Sample contained stones and shells.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-10
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1-10
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	1-10
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-10
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-10
Total Cyanide Distillation*	Distillation of sample as received. APHA 4500-CN^- C 22^{nd} ed. 2012.	-	1-10
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-10
Total Recoverable Selenium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	20 mg/kg dry wt	1-10
Total Recoverable Vanadium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	100 mg/kg dry wt	1-10
Total Cyanide*	Distillation, colorimetry. APHA 4500-CN^- C (modified) & E (modified) 22^{nd} ed. 2012.	0.10 mg/kg dry wt	1-10
pH*	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-10

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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